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ORGANIZATIONS, RISK TRANSLATION AND THE ECOLOGY OF RISKS:

THE DISCURSIVE CONSTRUCTION OF A NOVEL RISK

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Abstract

The contemporary 'risk society' is associated with the emergence of a wide range of risks characterized by uncertainty and unfamiliarity. These 'novel' risks pose a major challenge for organizations: their negative effects may be significant, but prevailing risk assessment techniques are limited in their ability to identify them. Building on our prior work on the chemical bisphenol A (BPA), this study examines how organizations deal with novel risks. It finds that organizations engage in 'risk translation' by translating equivocality associated with the novel risk into more familiar risks, providing them with a clearer basis and guide for action. As multiple organizations take actions to manage these translated risks, the interactive effects result in an 'ecology of risks' that evolves over time, allowing for the construction of a novel risk. The study contributes to research on organizing and risk by theorizing how organizations respond to novel risks, as well as by highlighting the role of translated organizational risks in constructing novel risks and shaping societal responses to grand challenges.

Keywords: Risk, novel risks, risk translation, ecology of risks, discourse, BPA

Risk is a prominent feature of contemporary organizing: organizations produce, bear and manage a wide range of different risks. Insofar as risks are seen as “the potential for realization of unwanted, adverse consequences” (Society for Risk Analysis, 2015: 3), the “anticipation of catastrophe” (Beck 2006: 332), or “the chance of mishap” (Cranor, 2007: 38), organizations have introduced increasingly sophisticated measures in attempts to avoid or manage them. These measures typically rely on the use of quantitative risk assessment techniques to calculate the probability that an adverse effect or negative event will occur, and to measure the nature and magnitude of its impact if it does. Consequently, technocratic ‘risk talk’ and ‘risk work’ (Power, 2004, 2016) pervades modern organizations based on the assumption that, by employing these techniques, organizations will be able to identify and act on the risks that they face. In this way, a ‘realist’ approach to risk allows organizations to transform uncertain and potentially hazardous futures into knowable, manageable risks (Jasanoff, 1998).

Many organizations, however, face ‘novel’ risks, which are characterized by uncertainty and unfamiliarity and, therefore, *cannot* be identified by using quantitative risk assessment techniques (Beck, 2006; Giddens, 1999a). Examples include risks associated with genetically modified organisms, nanotechnology, electromagnetic fields, persistent organic pollutants, and bird flu. In such cases, unfamiliarity and/or complexity make it impossible for organizations to be certain “whether the particular activity, product or phenomenon constitutes a risk to humans and/or the environment” (van Asselt & Vos, 2008: 281). In these circumstances, scientific analysis “seems to produce as much uncertainty as certainty” (Arnoldi, 2009: 85). Accordingly, the realist approach is limited in its ability to address novel risks: how can an organization identify and act on a risk if the probability, nature and magnitude of its adverse effects cannot be ascertained through prevailing scientific knowledge and practices?

A ‘discursive’ approach to risk has been proffered as an alternative to the realist approach (Jasanoff, 1998). It challenges the idea that risk is an objective or ‘real’ phenomenon and, instead, examines how particular entities, activities or individuals are *constructed* as posing risks (Lupton, 2013). Discourse theorists do not dispute that the dominant discourse of risk is premised on the idea that risks can be measured and managed through scientific analysis, but they do dispute that these quantitative techniques ‘reveal’ pre-existing risks. Rather, they argue that these techniques – because of their authoritative status – are an important way of categorizing objects as ‘risky’ or ‘safe’ (Maguire & Hardy, 2013). In other words, by bringing the discourse of risk to bear on a particular object and applying the prevailing body of risk knowledge, meanings in relation to risk are attached to it (Hardy & Maguire, 2016). However, a discursive approach is also limited in the case of novel risks since it does not explain how risks can be constructed if the body of risk knowledge *lacks* sufficient authority to ‘fix’ the object’s meaning and ascertain whether it poses a risk or not.

In this paper, we explore the challenges posed by novel risks by examining how diverse organizations in two different countries acted with regard to bisphenol A (BPA) between 1993 and 2013. BPA is a synthetic chemical found in a wide range of products, including baby bottles, water bottles and food can linings. It has come to be constructed as posing novel risks to human health and the environment by interfering with the hormone systems of humans and animals. This study extends earlier research where we investigated a single organization – Canadian regulators – to identify the practices used to construct BPA as a ‘risk object’ and to examine how these practices differed from those used in the construction of another more established, familiar risk (Maguire & Hardy, 2013). The earlier study was able to identify these practices by ‘zooming in’ with a detailed investigation of one organization. However, as Nicolini (2009: 1407) points

out, zooming in is only “part of the job” since “activities never happen in isolation [and] ... practices are always immersed in a thick texture of interconnections.” This is particularly the case with risk because its complexity and ubiquity make it necessary not only to understand individual organizational responses, but also to reflect on the broader patterns that emerge from them (see Palermo, Power & Ashby, 2017).

Accordingly, in this study we ‘zoom out’ – extending our research to include different types of organizations in more than one country and to cover a longer period of time (cf. Nicolini, 2009). Zooming out provides us with answers to questions that could not be addressed in the earlier study. For example, while Canadian regulators found that BPA posed a risk, we did not know whether the same was true of regulators in other countries or other types of organization and, if so, whether they used the same practices. It is important to ascertain how different types of organizations respond to novel risks because the latter are argued to have significantly damaging effects for a wide range of organizations (e.g., Beck, 1992; Giddens, 1999a). Further, the original study could not address whether the responses of different organizations interacted with each other and, if so, to what effect. It is important to examine whether actions by one organization affect those of another and, if so, whether the effect is complementary or contradictory because processes of construction are typically shaped by ‘discursive struggle’ among organizations (e.g., Maguire & Hardy, 2009). By zooming out, this study is able to address these questions and show the variation in how different organizations respond to a novel risk, as well as the impact of the interactions that arise among these responses.

The findings of this study thus make a number of contributions that go beyond those of the earlier study. First, we show the importance of ‘risk translation’ as diverse organizations translate the equivocality associated with a novel risk into more familiar organizational risks,

such as reputational, regulatory and operational risks, and then take actions to manage them. In other words, an organization deals with a novel risk by focusing on a different, more familiar risk. Second, we show how novel risks are situated in an ‘ecology’ of risks that is constituted by the risks translated by multiple organizations and the interactions among them. We explain how the evolution of this ecology of risks shapes the object’s meaning in relation to risk over time, eventually leading to its construction as a risk object. Third, we provide a generalizable model that not only helps to explain the complex processes involved in the construction of novel risks, but which also sheds light on cases where an object appears to become *less* risky over time and is *not* constructed as a risk object. Finally, this model offers insights into ‘wicked problems’ and ‘grand challenges’ such as climate change, where science has been unable to lay uncertainty and controversy to rest and where risk translation and the ecology of risks play an important, but hitherto unexplored, role.

ORGANIZATIONS AND RISK

In contemporary society, risk is used to control the future – by calculating the likelihood that an adverse event will arise and the damage it will cause, uncontrollable dangers become manageable risks (Beck, 1992; Giddens, 1999a). This has led to a ‘realist’ approach (Jasanoff, 1998), which emphasizes “technocratic, decisionistic, and economic models of risk assessment and management” (van Asselt & Renn, 2011: 436).

The traditional technical foundation of risk management is risk analysis, a discipline whose strength consists in its machine-like, engineering quality. Standard conceptions of risk analysis focus on identifying, measuring and evaluating possible outcomes from both natural and technological hazards (Hutter & Power, 2005: 7).

In employing such techniques, it is assumed that organizations can identify and manage risks by calculating the probability that a negative event will occur, and measuring the nature and

magnitude of its impact if it does (Jasanoff, 1998). According to this view, hazards and risks are objective features of reality that can be ascertained through analysis (Hilgartner, 1992), on the basis of which organizations decide whether and how to act on particular objects – entities, activities and individuals – in order to avoid unwanted, adverse consequences.

Rather than seeing risk as ‘real,’ a discursive approach examines the way in which *meanings* in relation to risk are attached to particular objects (Maguire & Hardy, 2013). This approach does not deny the importance of realist techniques in prevailing risk assessment and management practices. In fact, it acknowledges that they permeate the dominant discourse of risk (Lupton, 2013; Hardy & Maguire, 2016) in that risks are assumed to be “objectively quantifiable” (Miller, 2009: 30) and discoverable through the application of scientific knowledge and techniques. However, whereas from a realist perspective these techniques ‘reveal’ whether features of reality constitute a risk, from a discursive perspective they constitute the rhetorical means by which a ‘risk object’ is constructed from three conceptual elements: “an object deemed to ‘pose’ the risk, a putative harm, and a linkage alleging some form of causation between the object and the harm” (Hilgartner, 1992: 40). In other words, the discourse of risk is brought to bear on entities, activities or individuals as the existing body of risk knowledge, which is constituted by widely accepted, standardized statistical and scientific techniques associated with risk assessment and management, is applied to them (Hardy & Maguire, 2016). These techniques – because of their authoritative status – are what make it possible to name an object and link it to a harm, thereby constructing a risk object. They “produce ‘truths’ on risk that are then the basis for action” (Lupton, 2013: 113). In this way, the dominant discourse of risk provides a ‘regime of truth’ – an accepted way to establish whether a risk ‘exists’ or not.

Each society has its regime of truth, its ‘general’ politics of truth: that is, the type of discourse which it accepts and makes function as true; the mechanisms and

instances which enable one to distinguish true and false statements, the means by which each is sanctioned; and the techniques and procedures accorded value in the acquisition of truth; the status of those who are charged with saying what counts as true (Foucault, 1980: 131).

Even though statistical and scientific techniques based on realist assumptions are used, the risk is still discursively constructed. In fact, its construction is made authoritative *as a result of* them.

Novel Risks

In recent years, technological progress has been held accountable for producing new risks that cannot be identified by prevailing scientific techniques (Arnoldi, 2009). Researchers distinguish them from ‘routine’ (van Asselt & Vos, 2008), ‘familiar’ (Rudisill, 2013), ‘knowable’ (Huang & Pearce, 2015), or ‘established’ (Maguire & Hardy, 2016) risks. Beck (2006: 334) refers to them as ‘global’ risks, whose “consequences are in principle incalculable” because they “are based on science-induced not-knowing.” Giddens (1999b: 4) calls them ‘manufactured’ risks, “for which history provides us with very little previous experience”. Other terms include ‘emerging’ risks (e.g., Flage & Aven, 2015; Mazri, 2017), ‘new’ risks (e.g., Godard, Lagadec & Michel-Kerjan, 2003; Borraz, Gilbert & Joly, 2007), and ‘uncertain’ risks (e.g., Aven & Renn, 2009; Jansen et al., 2018).¹

Uncertain risks need to be sharply distinguished from traditional, simple risks which can be calculated by means of statistics on frequencies and actual impacts. Approaches, tools, routines, procedures and structures that work quite well in the regulation of simple risks are not just inadequate, but may even hamper responsibly dealing with uncertain risks. In the case of uncertain risks, basic, seemingly simple, questions as to whether there is a ‘real’ risk or whether there is ‘enough’ safety cannot be answered by science (van Asselt & Vos, 2008: 282).

We use the term ‘novel’ to encompass these different terms and refer to risks that are associated

¹ Knight (1921) differentiated risk from uncertainty, arguing that the former represented events whose probability distribution was known, while uncertainty referred to events whose probability of occurrence could not be specified. However, more recent writers, such as Beck (1992) and Giddens (1999a, 1999b), explicitly *combine* risk and uncertainty (see Arnoldi, 2009). Van Asselt and Vos (2008: 294) argue that “notwithstanding Knight’s famous distinction between uncertainty and risk, it has been convincingly argued that risk implies uncertainty.”

with uncertainty and/or unfamiliarity concerning the harm that an object may cause, the likelihood the harm will occur, and/or the causal processes connecting the object and the harm.

This uncertainty/unfamiliarity has been attributed to various factors, including complex causalities, a global scale, a long lead-time before negative impacts materialize, and catastrophic effects (e.g., Beck, 2006; Borraz, Gilbert & Joly, 2007; van Asselt & Vos, 2008; Vlek, 2010). Of course, such attributes are themselves socially constructed and there is likely to be differing opinions as to what constitutes ‘catastrophic’, ‘global’, ‘complex,’ etc. What is significant is that “classical risk analysis falls short of grasping such ill-defined problems” (Vlek, 2010: 517). This makes it impossible to quantify and calculate novel risks with any degree of reliability by applying prevailing scientific techniques (Arnoldi, 2009; Beck, 2006). In fact, attempts to apply “science and technology create as many uncertainties as they dispel” (Giddens 1999b: 4), resulting in risks that are “less readily identifiable, more problematic, less easily managed, and more anxiety-provoking” (Gephart, Van Maanen & Oberlechner, 2009: 142). In other words, the authority of the existing body of risk knowledge associated with the dominant discourse of risk lacks sufficient authority to establish whether a risk exists or not, changing the concept of risk “from one of probability to one of radical uncertainty” (Willms & Beck, 2004: 31).

In sum, whether or not an entity, activity or individual constitutes a risk object and poses a novel risk, and what should be done about it, are not straightforward matters. Novel risks are “objects of controversial knowledge. Their very definition is the subject of debates” (Borraz, Gilbert & Joly, 2007: 989). The challenge for researchers adopting a discursive approach, then, is to explain how meanings in relation to risk become attached to entities, activities or individuals when the body of risk knowledge associated with the dominant discourse of risk is unable to establish whether a risk exists or not. Accordingly, our first research question is: *How are risk*

objects constructed in the case of novel risks?

Organizations and Risk Translation

Novel risks pose a problem for organizations: insofar as scientific techniques do not have the desired effect of establishing certainty, organizations are required to assess and manage such risks “under conditions that are inherently uncertain” (Wardman & Mythen, 2016: 222).

Organizational processes are typically designed to deal with familiar, established risks and, as a result, are often ill-equipped to deal with them (Hardy & Maguire, 2016). We need, therefore, to examine how organizations respond to novel risks. One possible response, which we explore in this section, is risk ‘translation’ which, broadly speaking, refers to the process whereby an object’s meaning in relation to risk is changed. In using this term, we define translation as the transformation of meaning: “To translate is to transform, and in the act of transforming a breaking of fidelity towards the original source is necessarily involved” (Brown, 2002: 7).

Hilgartner (1992: 47) argues that risk translation – in changing whether and how a risk object is defined – can have strategic or political advantages, by helping to “redistribute responsibility for risks, change the locus of decision-making, and determine who has the right – and who has the obligation – to ‘do something.’” For example, researchers argue that, by promoting the discourse of enterprise as a means of limiting state obligations, governments have translated the meaning of risks associated with unemployment, old age and illness (Nayak, 2005; Lupton, 2013). Enterprising citizens are now expected “to calculate the potential outcomes of the choices they make; project the future consequences of current actions; modify their choices accordingly; and make personal provision for the future to reduce their dependence on broader society” (Ainsworth & Hardy, 2008: 394). Consequently, risks that used to be borne by the state are now individual risks – the responsibility of private citizens (Vaz & Bruno, 2003; Hacker,

2006).

[T]he individual is increasingly viewed today as an active agent in the risk-monitoring of collectively produced dangers; risk-information, risk-detection and risk-management is more and more constructed as and designed as a matter of private responsibility and personal security (Elliott 2002: 305).

Similarly, as “economic risk in modern life has increasingly become privatized and individualized” (Neff, 2012: 2), what were once risks borne by business organizations have also become individual risks. For example, contingent workers are now required “to expend their own resources to manage and mitigate workplace risks and damages” (Gephart, 2002: 333).

Translating the meaning of risks in this way means that responsibility and liability are ‘individualized’ i.e., redistributed from the state to the individual.

Risk translation also appears to go in the other direction i.e., some individual risks are translated into organizational risks.

Take the example of a safety notice about a slippery floor in a supermarket. As a matter of first-order risk management, the notice is there to protect the public. As a matter of defensive, secondary risk management, the notice is there to protect the organization in the event of legal action should someone slip over i.e., to communicate that reasonable steps were taken to inform the public (Power, Scheytt, Soin & Sahlin, 2009: 310).

In this example, the meaning of the risk has been translated in that the safety notice no longer simply protects the individual from the risk of slipping, it also protects the organization from the risk of litigation in the event that an individual does slip. This risk translation benefits the organization in two ways. First, risk management measures can be easily identified and put into place as risks are “translated into problems of organisational control systems,” making it easier for the organization to avoid or manage the risk (Power, 2004: 4). Second, despite translating an individual risk into an organizational risk, responsibility and liability remain with the individual. In the example above, even if an individual should slip, the organization is exempt from blame by having posted a warning. Thus, by translating organizational risks, organizations are also able

to benefit from the individualization of risk.

These two patterns of risk translation both assume that the organization is familiar with the risk in question when they engage in translation. The risks associated with unemployment, old age and illness are well-known to governments; as are the costs to the state of bearing those risks. There is, then, considerable economic benefit to translating them so that they become the responsibility of individuals. Similarly, organizations have developed sophisticated measures for dealing with regulatory, reputational, operational and strategic risks (Power, 2004). Insofar as organizations translate individual risks into these different categories of organizational risk, they do so knowingly – so that they can deploy the relevant risk assessment and management techniques. In other words, existing research suggests that organizations translate well-known risks in a conscious and strategic manner. However, we know from studies of translation in other settings that translation processes are not necessarily linear and determinate – meanings can be transformed in ways that were not necessarily intended (Czarniawska & Sevón, 1996; Zilber, 2006; Sahlin & Wedlin, 2008; Maguire & Hardy, 2009; Pallas, Fredriksson & Wedlin, 2016). This seems particularly plausible in the case of novel risks, where it is not possible to calculate either the costs of bearing the risk or the benefits of translating it. Insofar as existing research does not address whether and how translation occurs in the case of novel risks, our second research question is: *What is the role played by risk translation in the case of novel risks?*

METHODS

Research Setting

Our study concerns the chemical BPA, which was first synthesized in 1891. It is an important component of polycarbonate plastic used in baby bottles, reusable food and drink containers, as well as epoxy resins used as protective coatings on various forms of metal

equipment and the interior of food cans. Global BPA production is estimated to be around 5 million tonnes per year (Merchant Research and Consulting, 2014), of which two-thirds is used in polycarbonate plastic (IHS, 2015).

In 1993, BPA was categorized as an ‘endocrine disrupting’ chemical, meaning that it could potentially adversely affect the endocrine (hormone) system of humans and animals (Bern et al., 1992; Korach, 1993). This harm was, however, unfamiliar since the concept of endocrine disruption had only emerged in the 1990s (see Colborn, Dumanoski & Myers, 1996).

Furthermore, the causal pathway through which BPA ostensibly causes harm to human health and/or the environment was unclear – despite a growing number of studies of BPA, results are mixed as to whether and how it causes adverse effects (e.g., Stone, 1994; Hileman, 1997; Fox, Versluis & van Asselt, 2011). This disagreement as to whether or not BPA poses a risk extended beyond the scientific community: regulatory responses have been varied and, while retailers have withdrawn products containing BPA, chemical manufacturers have continued to manufacture BPA and to assert that it is safe. Accordingly, we selected BPA because it potentially posed a novel risk and examined it from 1993, when it was added to the list of potential endocrine disruptors (Gies & Soto, 2013), until 2013 in order to examine how different organizations engaged with it over time. Bearing in mind the global nature of novel risks and that they typically affect a wide range of organizations in different countries, we included organizations in Canada and Australia whose similar, centralized chemicals management system make it feasible for in-depth study compared with much larger systems such as the USA or EU.

Data Collection

We conducted a series of systematic searches for mentions of BPA in a wide range of texts between 1993 and 2013, extending the time period of our earlier paper (Maguire & Hardy,

2013), which concentrated on the period from 2006-2009, in order to allow us to zoom out (cf. Nicolini, 2009). We searched articles published in *Science* to capture the scientific debate, as well as news reports, opinion pieces, and editorials through *Environmental Health News* (an aggregator of media coverage of environmental health issues) to capture the broader societal debate. We also searched the archives of national broadcasters – the Canadian Broadcasting Corporation (CBC) and Australian Broadcasting Corporation (ABC) – and of two national newspapers – the *Globe and Mail* in Canada and the *Australian* in Australia. We searched the websites of regulatory agencies, NGOs, manufacturers and retailers and collected documents these key actors had authored during the period 1993-2013, adding to the texts from the Canadian government’s website that we had collected for our earlier paper (Maguire & Hardy, 2013). The additional texts collected for this study included the texts from three Australian regulators, articles published in *Science* and *Environmental Health News*, all the media reports, all the materials from the websites of NGOs, manufacturers and retailers, and Canadian government texts published after 2009.

In addition to collecting these additional texts, we also conducted a series of interviews. In 2011 and 2012, we interviewed representatives of key groups, including scientists, government regulators, and representatives of chemical manufacturers, retailers, and NGOs in both countries (see Table 1 for a summary of interviews by actor type and country). Interviews lasted between 30 and 90 minutes, were recorded and transcribed verbatim. Questions were semi-structured: interviewees were asked to describe their role in chemicals management and to recount the story of BPA from their perspective.

– Table 1 near here –

Data Analysis

We commenced our analysis by examining how the key actors – scientists, chemical manufacturers, regulators, retailers and NGOs – talked (or wrote) about BPA. We noticed that they linked it to a wide range of negative effects. We then examined these accounts in more depth and noted how, in these accounts, actors described themselves as *risk subjects* i.e., they were threatened in some way by a *risk object* i.e., an entity, activity or individual that posed a risk, which was not necessarily BPA. Some groups produced convergent accounts while others differed, as summarized in Table 2. We distinguished between the accounts of two groups of scientists – ‘endocrinologists’, who study the hormone systems of humans and animals, and ‘toxicologists’, who study the adverse effects of chemicals.² Chemical manufacturers, which were mainly global organizations, produced highly convergent accounts. Retailers, even though they involved separate organizations in the two countries, also produced convergent accounts; as did NGOs in the two countries. The accounts of ‘Canadian regulators’ and ‘Australian regulators’ differed from each other. Through further analysis of these accounts, we inferred that the various groups had translated BPA’s equivocality into other risks with which they were more familiar. We categorized these *translated risks* as professional, regulatory, reputational, and operational (Table 2).

– Table 2 near here –

We then documented the specific actions taken by the different actors to manage the particular risk that they had translated, which we analyzed in two stages. First, we analyzed the effect of these *risk management actions* on BPA’s meaning in relation to risk. We did so by undertaking a series of iterative steps involving coding at descriptive, analytical, and

² We used these labels as a form of descriptive shorthand – we do not imply that *all* endocrinologists or *all* toxicologists conform to the patterns associated with the labels as discussed here.

pattern/inferential levels of analysis (cf. Miles & Huberman, 1994) as shown by the data structure diagram in Figure 1. Through our descriptive coding we were able to link the *translated risks* with the *specific risk management actions* taken to address them. Our analytical coding then allowed us to identify whether risk management actions targeted the *existing body of risk knowledge* in relation to BPA (i.e., the scientific methods used in, and findings from, the assessment of BPA's risks) or whether they targeted the *object of risk knowledge* (i.e., BPA) directly. Finally, through pattern coding we found that risk management actions that promoted the use of existing scientific methods, referenced extant research, invoked established scientific experts, and/or referred to the actions of other jurisdictions as precedent *weakened* BPA's meaning in relation to risk. They did so insofar as they emphasized that BPA was like any other chemical and should be assessed according to the existing body of risk knowledge, which typically failed to find evidence of risk. Risk management actions that targeted the existing body of risk knowledge by disputing 'facts', challenging established experts, and/or promoting alternative methods *strengthened* BPA's meaning in relation to risk. Similarly, risk management actions that targeted BPA directly, by singling it out for exceptional treatment, whether by subjecting it to special protocols or treating it as if it posed a risk, also strengthened BPA's meaning in relation to risk.

– Figure 1 near here –

In the second stage, we analyzed the effect of risk management actions of each actor on the risks translated by other actors. We started by noting when different actors began to take action, and how long those actions endured. This involved an iterative approach where we established evidence of a risk management action from our data and then tracked backward to see if there was any evidence to suggest it had begun earlier. So, for example, we found evidence

that Mountain Equipment Company (MEC) was the first Canadian retailer to withdraw products containing BPA in 2007. We could not find any evidence of earlier withdrawals in Canada, although we cannot rule them out completely. We did find extensive evidence of subsequent withdrawals by other Canadian retailers in 2008 and by Australian retailers in 2010. Having established a ‘start date’ for risk management actions, we then tracked forward to see if they continued and found that, in all cases, they continued to 2013 (Figure 2).

– Figure 2 near here –

Having established the sequencing of risk management actions by different actors, we then investigated the interactions among them – again in a highly iterative, inductive process. We found that, in some cases, actions taken by one actor to manage their translated risk *heightened* the translated risk of other actors. For example, we inferred that the risk management actions of Canadian NGOs heightened the reputational risk translated by Australian NGOs from the sequencing of demonstrations, press releases and publications – actions in Canada clearly preceded similar actions in Australia NGOs – and from interviews, with comments like:

“Probably the only reason we got anywhere with BPA, we were lucky enough to have the boys out from Canada.” In other cases, we could not find evidence that risk management actions taken in relation to one translated risk heightened another. See Table 3 for details. From these analyses, we were able to look holistically at our data to document how aggregate patterns of risk translations, risk management actions and the meaning of BPA changed over time. In this way, we were able to conceptualize an evolving ecology of risks for BPA, which we discuss below.

– Table 3 near here –

RISK TRANSLATIONS

In this and the following two sections, we present our findings. Here, we discuss how

actors translated equivocality regarding BPA into more familiar risks.

Translating Professional Risk

Early studies by endocrinologists suggested that BPA posed a risk by interacting with cellular hormone receptors in ways that resulted in lower doses or exposure posing higher risks (e.g., Krishnan et al., 1993; Nagel et al., 1997). These findings contradicted the basic principle of toxicology i.e., that the ‘dose makes the poison,’ which takes for granted that the *greater* the exposure, the more likely there are to be toxic effects. In responding to these findings, toxicologists linked BPA to methodological bias on the part of endocrinologists whose findings were thus highly questionable. “This has been blown way out of proportion” as one toxicologist (quoted in Stone, 1994: 308) argued. Toxicologists criticized endocrinologists for using unvalidated, non-standardized methods, focusing on outcomes that did not represent significant negative health effects, and being unable to replicate their studies (Fagin, 2012). In conducting and disseminating what toxicologists viewed as flawed research, based on inappropriate methods and leading to spurious findings, endocrinologists were threatening toxicologists’ professional integrity.

We suspect there is a lot of baloney here (Toxicologist, quoted in Stevens, 1994).

My personal view is that the politics intrudes into the literature of Bisphenol A much too greatly (Australian scientist [A14]).

In this way, toxicologists translated equivocality associated with BPA into a version of professional risk where they saw themselves as risk subjects whose professional integrity as scientists was threatened by endocrinologists (the risk object) conducting and disseminating flawed research based on dubious methods. The endocrinologists represented – for toxicologists – a threat “not only to science, but to the very principles of an enlightened governance and social contract” (Dietrich et al., 2013: A1).

Endocrinologists also linked BPA to methodological bias, but on the part of toxicologists.

They argued that endocrine disruption represented a new ‘paradigm’ (e.g., Fairley, 1996).

The issue of the amount of hormone that actually causes effects is very difficult for scientists to talk to people about because we're dealing with numbers that are outside of the frame of reference that anybody is going to be thinking about. ... But what you have is the entire field of toxicology thinking of a millionth of a gram of a hormone or a chemical as being this staggeringly tiny amount ... When you are raised in the field of toxicology you are looking at that from the other perspective of ‘My gosh, that's such a tiny dose, it couldn't do anything’ (vom Saal, 1998).

It was not surprising to endocrinologists, therefore, that BPA did not conform to the principle of the ‘dose makes the poison’ (Vandenberg et al, 2009).

Another key shift [in scientific thinking] is the acknowledgement that the assumption that the dose makes the poison can be misleadingly simplistic (Myers, 2002).

Toxicologists who failed to engage with this new paradigm were accused of being wedded to an outdated methodology that was insensitive to low-dose effects, resulted in ‘false-negatives’, and stymied research in an important new area.

[A]n editorial was published by 18 toxicology journal editors seeking to dismiss the state-of-the-science on environmental endocrine-disrupting chemicals (EDCs) ... [It] is flawed, as it is not soundly rooted in the fundamental biological properties of hormones, their receptors, and physiological responses. It neglects to mention over a half-century of research that has led to the well-established understanding that hormones act at extremely low dosages. It ignores the literature showing that natural hormones and EDCs can cause permanent cellular and molecular changes to organs and tissues (Gore, 2013: 3955).

In this way, endocrinologists also translated equivocality related to BPA into a version of professional risk – one where they saw themselves as risk subjects whose professional integrity as scientists was threatened by toxicologists (the risk object), who conducted and disseminated flawed research based on inappropriate methods.

Translating Regulatory Risk

Chemical manufacturers linked BPA to the possible introduction of regulations by

governments to limit its sale and/or production. Such regulations would, in turn, deprive these firms of revenues, impose additional costs on them, and restrict their business opportunities. Chemical manufacturers started to translate BPA's equivocal meaning in relation to risk into regulatory risk in the 1990s, when they set up a committee on endocrine disruption.

Everything is at stake for the industry on this one. ... This is entirely new for them. It was a day of reckoning that they didn't want to see, and everything depends on what they find out with endocrine disruption (Forsyth, 1998).

They opposed regulations on grounds of 'inconclusive science' and costs of trade restrictions:

Risk management measures should not include a ban on the use of polycarbonate for manufacture of baby bottles. Rather than imposing trade restrictions based on inconclusive science, we suggest that bisphenol A be subject to further study and that the government investigate alternative risk management options that are available to it. ... The listing and regulation of bisphenol A as a "toxic" substance will have significant economic impacts and entail substantial disruption (comments from industry representatives, reported in Environment Canada and Health Canada, 2008).

In this way, chemical manufacturers (and their industry associations) translated equivocality associated with BPA into a regulatory risk, where they were risk subjects threatened by governments (the risk object) considering the implementation of new regulations.

Translating Reputational Risk

Retailers had been selling products containing BPA for many years without any consideration of risk. However, in the mid 2000s, Canadian retailers started to link BPA to products that were attracting adverse media and NGO attention, thereby generating customer concerns. Australian retailers did the same slightly later. Baby bottles containing BPA, in particular, were receiving negative publicity for the harm they might cause babies and infants.

If we're talking about the BPA in the baby bottles, that I think was a clear case of external awareness, customer concern because we did have to move on that. So, that was an external pressure on [us] and a concern (Australian retailer [A25]).

Other products containing BPA, such as plastic water bottles, also concerned retailers because

consumers were worried that they could damage the environment.

This green consumerism phenomenon goes back to 2005 and it still propels the [BPA] issue. It's a very significant phenomenon (Canadian NGO representative [C24]).

Retailers (the risk subject) in both countries thus translated equivocality associated with BPA into a reputational risk: certain products containing BPA were risk objects because they could cause a consumer backlash that would damage their reputations if they continued to sell them.

Canadian and Australian NGOs also linked BPA to a range of commonly used products that were starting to raise concerns among donors and members because they contained endocrine disrupting chemicals. As the evidence that BPA caused harm mounted, NGOs risked losing their credibility, as well as public and financial support, if they did not take action.

My impression is that it was a fairly important moment in the development of this area [of NGO advocacy] when it became clear ... that Canadians were really paying attention to [BPA] (Canadian NGO representative [C24]).

The reason BPA got taken up [by NGOs] is that it was simply so high-profile and there was so much publicity about it (Australian NGO representative [A27])

In this way, NGOs in both countries also started to translate BPA's equivocal meaning into a reputational risk – the various products containing BPA were risk objects insofar as failing to take action against them could damage the reputations of NGOs (the risk subject) as conscientious, activist protectors of individuals' health and the environment.

Translating Operational Risk

Canadian and Australian regulators both linked BPA to chemicals management more broadly, but in two very different ways. By the mid 2000s, Canadian regulators were starting to question whether existing chemicals management processes were adequate to assess accurately the risks of endocrine disrupting chemicals like BPA.

We pay a lot of attention to endocrine disruption [and BPA]. I think a huge amount of our Chemicals Management Plan research funding goes into endocrine

disruption and ... trying to ... come up with standardized tests that will get us something to give us a better indication of whether something's adverse (Canadian regulator [C8]).

Canadian regulators also saw BPA as representative of a number of other 'legacy' chemicals (chemicals in use) that required new, speedier forms of risk assessment since they were already in the economy and might be causing harm.

Canada is the first country in the world to take action on bisphenol A, thanks to our Chemicals Management Plan. This Plan was introduced in 2006 to review the safety of widely used chemicals that have been in the marketplace for many years (Government of Canada, 2012).

Canadian regulators thus translated BPA's equivocality into an operational risk: existing risk assessment and management processes were not capable of dealing with the particular challenges of chemicals like BPA. Maintaining existing processes (the risk object) threatened the ability of regulators (the risk subject) to conduct the timely and effective management of chemicals.

Australian regulators also linked BPA to existing chemicals management processes, but they did not see a particular problem with endocrine disrupting chemicals like BPA. Instead, they saw BPA as steeped in emotional debate, irrational public fear, and political pressures. Even though media coverage was less extensive in Australia than Canada, high-profile TV programs had heavily criticized how government agencies had handled BPA. In the view of Australian regulators, deviating from the existing, science-based approach to chemical risks in response to media or political attention would severely compromise effective chemicals management.

You can't just do regulation on the basis of media stories or perception. It's just not a viable approach. There has to be some scientific evidence base and there has to be a system to do it (Australian regulator [A11]).

Australian regulators thus translated BPA's equivocality into another version of operational risk, in which changes to existing processes (the risk object) to address publicized and politicized chemicals like BPA threatened the timely and effective management of chemicals by

government regulators (the risk subject).

ACTIONS TO MANAGE TRANSLATED RISKS

In this set of findings, we describe the actions actors took to manage their translated risks.

Managing Professional Risks

The actions of toxicologists to manage their version of professional risk involved conducting studies using accepted toxicology protocols, which produced findings that failed to show adverse effects. They highlighted studies that had been intended to replicate findings of adverse effects of BPA at low doses, but which failed to do so, citing them as evidence that the original studies were flawed (e.g., Sharpe, 2010). They also referenced the reports of regulatory agencies that had reviewed the research on BPA and concluded that it did not pose risks.

The U.S. Food and Drug Administration came up with a statement: “there is no convincing evidence that BPA at current exposure levels is a risk. The European Food Safety Authority said last year that in their mind there was “no evidence to revise the tolerable daily intake.” The World Health Organization ... said in their review that it was “premature to initiate public health measures. Japan ... reaffirmed their previous position saying that there is not risk at current exposures. The Germans ... came out with a paper last year, which I found pretty interesting, stating that there was “no noteworthy risk to health” (Canadian scientist [C13])

Toxicologists criticized the research of endocrinologists by arguing it did not adhere to traditional, well-established scientific principles. For example, one headline in *Science* declared that “many toxicologists are questioning reports that estrogen-like compounds [i.e. endocrine disrupting chemicals] could be a threat to human reproductive health” (Stone, 1994: 308). Our interviewees continued to raise similar questions some eighteen years later:

Our concern is that if the government starts supporting that kind of approach, science just goes out the window ... The only kind of certainty you can have is if you’ve got some sort of robust model. At the moment, the scientific paradigm is that model. We don’t have an alternative (Australian scientist [A16]).

Toxicologists argued that regulation should be based on established principles of *toxicology* and

it was “the utmost responsibility of us scientists to resist and counteract any efforts [by endocrinologists] that undermine the core of science and its continuing promise for the betterment of the human condition and of the planet” (Dietrich et al., 2013: A1).

Endocrinologists’ risk management actions involved further development of specialized methods to identify low dose effects (e.g., Nagel et al., 1997; Vandenberg et al., 2013a; vom Saal et al., 2007), resulting in a growing number of scientific articles suggesting that BPA posed risks (Vogel, 2009). They took actions to discredit toxicologists by challenging the findings of studies that had received industry funding and found no adverse effects (vom Saal & Welshons, 2006).

Frederick vom Saal is a respected American biology professor who keeps a running tally of the scientific literature investigating the health effects of bisphenol A ... By his count, 130 papers have been published on the effects of low-dose exposures to the chemical. Dr. vom Saal ...found that more than 90 percent of the government-financed studies noted adverse effects from the chemical, but not one of the 11 industry-backed ones (Mittelstaedt, 2006).

In 2013, when toxicologists sent an open letter to European Union (EU) regulators advocating for traditional toxicological principles to be used to regulate endocrine disrupting chemicals (Dietrich et al., 2013), endocrinologists highlighted the industry ties of 17 of the 18 signatories (Horel & Bienkowski, 2013). Endocrinologists acknowledged their findings challenged “risk assessment dogma,” but argued “society’s tendency to maintain the status quo is insufficient as an argument to rebut scientific data” (Vandenberg et al., 2013b: 11). They countered the toxicologists’ letter to the EU by arguing that regulation should be based on the new paradigm.

Policymakers in Europe and elsewhere should base their decisions upon science, not assumptions based upon principles that arose out of research on chemicals that are not EDCs [endocrine disrupting chemicals] (open letter by endocrinologists responding to Dietrich et al. (2013), published in endocrinology journal, see Gore et al., 2013: 3).

Managing Regulatory Risks

To address regulatory risk, chemical manufacturers took a number of actions, including

funding research. An Endocrine Issues Coordinating Group was set up by the International Council of Chemical Associations with a research budget of US\$20 million to fund “independent research in government, university and contract laboratories” (industry representative, quoted in Australian Academy of Science, 1998: 8). The Bisphenol A Task Group was set up in 1997 to fund research (Staples et al., 1998) and, a decade later, the Polycarbonate/Bisphenol A Global Group – a global industry association of major manufacturers – was established to engage “in activities ranging from scientific research through communication with the scientific community, government agencies, our customers, retailers and consumers” (Canadian Plastics, 2007).

Chemical manufacturers sought to exclude studies using non-traditional methods that had found evidence of harm, arguing they were characterized by unrealistic estimates of exposure, untested methods, and the failure to use internationally accepted practices to establish validity. An evaluation of the research on BPA, conducted by the Harvard Center for Risk Analysis and funded by the American Plastics Council concluded that the ‘weight of the evidence’ for low dose effects was very weak (Gray et al., 2004). Chemical manufacturers also invoked jurisdictions that had concluded that BPA was safe.

Government and scientific bodies around the globe have extensively evaluated the weight of scientific evidence on BPA and have declared that BPA is safe as used, including in materials that come into contact with food, such as reusable food storage containers and linings in metal cans (American Chemistry Council, 2012).

To promote further the conclusion that BPA was safe, the American Chemistry Council established a number of websites, under different names (*factsaboutbpa.org* and *bisphenol-a.org*) and produced content for other websites (*plasticsinfo.org*) in order to disseminate information on BPA, with references to studies and reviews that had found it to be safe.

Managing Reputational Risks

Canadian retailers’ actions to manage reputational risk involved withdrawing products

containing BPA from sale from late 2007 and substituting them with ‘BPA-free’ products.

Retailers are the most sensitive [industry group] when it comes to responding to changing consumer trends. So, in Canada ... it was big retailers first that started to move to strip their shelves of BPA inventory (Canadian NGO representative [C24]).

Mountain Equipment Co-op (MEC), an environmentally oriented cooperative in Canada withdrew products containing BPA in December 2007 – four months prior to the publication of the Canadian government’s draft report that declared BPA to be toxic.

We have stopped selling polycarbonate water bottles and food containers. These products are not defective and have not been recalled. We have stopped selling them ... because our members [customers] have expressed concern about this potentially harmful chemical (MEC, 2007).

Other Canadian retailers soon followed, including Wal-Mart Canada, Canadian Tire, Hudson's Bay Co., and Sears Canada. Australian retailers engaged in similar actions, although somewhat later. In 2010, the Wesfarmers group, Woolworths, Big W and Aldi signed a voluntary agreement coordinated by the Australian government to phase out baby bottles containing BPA.

There was a groundswell of consumer sentiment suggesting that BPA is perhaps not the best thing ... I think it was important for customers to understand that, if they were sufficiently concerned, we would listen to them and we would provide an alternative for them, which is essentially what we did (Australian retailer [A26]).

Retailers in both countries also started to provide ‘BPA-free’ alternatives. Websites dedicated to BPA-free products proliferated, such as *CanadianLiving.com*, *mamababy.com* and *shopnaturally.com.au* which declared: “Everything we sell that's designed to touch food or drink is BPA-free.” The term ‘BPA-free’ became, in the words of one retailer [A25], “entrenched in the [market] category language”.

The actions of NGOs to manage their reputational risk involved bringing the scientific findings associating BPA with harm to the attention of consumers, lobbying politicians for a regulatory response, and trying to convince retailers to withdraw products containing BPA. In

2005, Canadian NGO Environmental Defence published a report identifying BPA as an endocrine disrupting chemical and, in 2007 and 2008, published the results of an in-house study indicating that three major brands of baby bottles leached more BPA when filled with water and heated. NGOs held demonstrations like the ‘baby rally’ held outside the Ontario Legislature on National Children’s Day in 2007, calling for a ban on baby bottles containing BPA.

I think they [government and retailers] had been lobbied pretty hard by [the NGOs] and I really give them full marks for doing that ... (Canadian NGO representative [C23]).

In Australia, Friends of the Earth published a consumer guide on BPA in 2008, as well as a critique of the lack of regulation (Friends of the Earth Australia & Europe, 2008a; 2008b).

An important aspect of turning public and government opinion in relation to BPA around is taking action in the marketplace. If everybody or a large proportion of consumers stopped buying baby bottles or other products containing BPA, manufacturers would get the message very quickly (Friends of the Earth Australia & Europe, 2008b: 18).

In 2010, the National Toxics Network (2010) issued a media release claiming BPA in food packaging “harms babies and children”, while the consumer group Choice released findings from an in-house study that found ‘concerning levels’ of BPA in canned baby food.

Managing Operational Risks

Insofar as existing assessment processes constituted a risk object for Canadian regulators, they went about changing them. They introduced the new *Challenge* program in 2006 to fast-track risk assessments of legacy chemicals, and increased coordination between Health Canada and Environment Canada to conduct joint assessments. In 2007, they announced that BPA would be assessed under this program. They also started to question the traditional separation between risk assessment and risk management, whereby risk assessors make a scientific determination of whether and to what extent a chemical poses risks, only after which do risk managers develop appropriate policy measures. Regulators argued that it was slowing down the assessment process.

[Previously] there'd be an assessment and then a significant gap between when the Government would say anything about what they were thinking ... it would probably be a year and a half later before stakeholders could get any kind of insight on what risk management might be (Canadian regulator [C8]).

Accordingly, risk assessors and risk managers began working together, especially in relation to chemicals like BPA, where there were high levels of concern on the part of the public.

[Risk managers are included in the process of preparing risk assessments] so that they have a better sense of all the issues, of the potential sectors involved or implicated, from an earlier stage. So, then they're not playing as much catch-up later on when you come up with a risk assessment conclusion. Plus, they can help us – they have a lot of contacts with different sector-based groups as well, so that they can help us with information gathering [about uses and exposure pathways] (Canadian regulator [C2]).

The result was 'Four Corners Governance', which brought together health, environment, risk assessment, and risk management, and which led to the conclusion that BPA did pose risks.

The governance that's in place is ... Four Corners Governance. At the director level there's a Health Canada Risk Assessment director, a Health Canada Risk Management director, an Environment Canada Risk Assessment director, and an Environment Canada Risk Management director ... [They] spend a lot of time together and every decision is basically a collective decision. Then that same governance exists at the Director General level and at the Assistant Deputy Minister level. So, everything – all substantial decisions – are made in that collective (Canadian regulator [C8]).

Australian regulators took very different risk management actions in light of their translation of a different version of operational risk. Insofar as *changes* to chemicals management posed a risk, they maintained a *commitment* to existing risk assessment processes. The National Industrial Chemicals Notification and Assessment Scheme (NICNAS) did not identify BPA as a 'Priority Existing Chemical' i.e., requiring priority assessment. Instead, two other agencies – the Australian Competition and Consumer Commission (ACCC) and Food Standards Australia and New Zealand (FSANZ) – assessed whether BPA in consumer products such as baby bottles or in the linings of food and beverage containers posed risks to human health. Both these agencies used traditional measures to assess the risks posed by BPA. For

example, the FSANZ Chief Scientist explicitly asserted “the basic principle of toxicology [is] that ‘the dose makes the poison’” (FSANZ, 2012). Risk assessment and risk management activities were also kept clearly demarcated in order to separate science from policy and to confine political pressures to the policy arena.

We’re trying to take a very straight down the line science approach to things and we are very rigorous in terms of distancing risk management from the risk assessment. There’s a physical separation ... between those two activities, but philosophically as well. We’re very much ‘the science says what the science says, right?’ Draw a line. Now decide what to do about it (Australian regulator [A7]).

The ACCC reaffirmed its position “that there is no detectable risk to Australian infants” (ACCC, 2010), while FSANZ confirmed that no regulation was warranted since “there was no detectable BPA in infant formula prepared in several typical infant feeding bottles” (FSANZ, 2010). Rather than changing existing processes to improve chemicals management, Australian regulators clarified and reinforced existing responsibilities – to ensure “that roles and responsibilities are clear and that there is no duplication of effort (Department of Health and Ageing and the Department of Finance and Deregulation, 2012: 10). So, whereas the version of operational risk translated by Canadian regulators led to the merging of roles and responsibilities, the version translated by Australian regulators led to clearer delineation of the differences among them.

AN EVOLVING ECOLOGY OF RISKS

In this third set of findings, we present what we refer to as an evolving ‘ecology’ of risks. It is constituted by the risks translated by multiple organizations and the interactions among them. We show how this ecology emerged and evolved in the case of BPA and explain how it shaped BPA’s meaning in relation to risk over time.

The ecology of risks starts to emerge in the early 1990s with the *possibility* that BPA might pose a risk. BPA thus became an object of risk knowledge as the discourse of risk was

brought to bear on it. However, the existing body of risk knowledge failed to fix BPA's meaning in relation to risk. Studies based on traditional toxicology principles did not find evidence that BPA posed a risk to human health or the environment, although research by endocrinologists suggested it might. As a result, at this stage BPA was *not* constructed as a risk object through the application of the existing body of knowledge. Instead, having previously been seen as safe, BPA's meaning in relation to risk started to become equivocal.

The two groups of scientists translated this equivocality into two versions of professional risk. The risk management actions that each group took to manage their professional risk heightened the professional risk of the other group. The more toxicologists refused to deviate from accepted toxicological protocols, the more endocrinologists were concerned about methodological bias threatening the integrity of science. The more endocrinologists challenged the body of risk knowledge based on 'the dose makes the poison' and developed a range of specialized methods, the more toxicologists were concerned about political bias threatening the integrity of science. Additionally, the risk management actions of endocrinologists heightened the regulatory risk translated by chemical manufacturers by providing evidence to justify regulations. This led manufacturers to intensify their risk management actions by funding research based on traditional toxicological principles, arguing against the use of innovative methods, continuing to manufacture BPA, and repeating claims that it was safe. These risk management actions, in turn, heightened the professional risk of endocrinologists.

Accordingly, during this early period, the ecology consisted of a small number of risks translated by endocrinologists, toxicologists and manufacturers. The actions taken to manage these translated risks had heightening effects on other translated risks leading to an intensification of the various risk management actions which reproduced the equivocality of

BPA's meaning in relation to risk. Studies by toxicologists using traditional toxicology methods found little evidence of harm, weakening the meaning of BPA in relation to risk. Studies by endocrinologists using non-traditional methods did find evidence of harm, strengthening its meaning in relation to risk. The risk management actions of manufacturers reinforced the risk management actions of toxicologists, weakening BPA's meaning in relation to risk (Figure 3a).

– Figure 3a near here –

From the mid 2000s, the ecology of risks started to grow as more risks were translated. Around 2005, Canadian regulators and Canadian NGOs began translating the ongoing equivocality concerning BPA into operational and reputational risks. Both these translated risks were heightened by the risk management actions of endocrinologists whose studies produced growing evidence of harm, reinforcing the need for special treatment for BPA by Canadian regulators to ensure effective chemicals management and adding to the pressure on Canadian NGOs to act. Additionally, the actions of Canadian regulators to manage their operational risk heightened the reputational risk of Canadian NGOs since the latter's supporters expected them to leverage the opportunity provided by the *Challenge Program* to advocate for stringent regulation. Similarly, by increasing public awareness and mobilizing opposition to BPA through their actions to manage reputational risk, Canadian NGOs heightened the operational risk of Canadian regulators.

The risk management actions of both Canadian regulators and Canadian NGOs heightened the regulatory risk of chemical manufacturers: the likelihood of restrictions on BPA increased as Canadian regulators fast-tracked BPA and Canadian NGOs mobilized public opposition. Accordingly, manufacturers intensified their risk management actions. They criticized the *Challenge* process, saying that “statements that specify that bisphenol A is

bioavailable and can accumulate in tissues are overstated and not supported by the weight of evidence. Such statements ... are based on a poorly described field study” (industry comments in Environment Canada and Health Canada, 2008). Following the release of the report concluding that BPA was toxic, the American Chemistry Council demanded a review, arguing that the assessment was not “based on the best available data and scientific knowledge” (Russell, 2009).

During this period, the actions taken to manage translated professional, operational and reputational risks by endocrinologists, Canadian regulators and Canadian NGOs strengthened the meaning of BPA in relation to risk, while those taken by manufacturers to manage regulatory risk and by toxicologists to manage their version of professional risk continued to weaken it. As a result, equivocality of BPA’s meaning in relation to risk also continued (Figure 3b).

– Figure 3b near here –

The ecology expanded further around 2007-2008 as Canadian retailers translated reputational risk, which was heightened by the actions of Canadian regulators to manage operational risk. Insofar as Canadian regulators had prioritized BPA, subjected it to new risk assessment processes, and then found it to be toxic, any retailer that continued to sell it was jeopardizing its reputation. Canadian retailers’ reputational risk was also heightened by actions by Canadian NGOs to manage their reputational risk which involved encouraging consumers to “reduce their exposure to harmful chemicals” and change their “purchasing habits” (Environmental Defence, 2005: 31). Accordingly, Canadian retailers intensified their actions to manage their reputational risk by withdrawing products that contained BPA and promoting ‘BPA-free’ products i.e., singling out BPA and treating it as if it posed a risk, regardless of what the body of risk knowledge said. As one Canadian retailer [C22] admitted: “Even though there was uncertainty about whether BPA was ... a harmful chemical ... the vast majority of

[consumers] really appreciated that we took that stand. ... I think we engendered a great deal of brand loyalty by virtue of that decision.”

During this period, not only did the equivocality continue but contestation started to become apparent among two groups of organizations. One group included those whose risk management actions strengthened BPA’s meaning in relation to risk: endocrinologists, who continued to publish research showing adverse effects; Canadian regulators, who concluded that BPA was toxic and were preparing to ban products containing it; Canadian NGOs, who supported the ban and advocated further restrictions; and Canadian retailers, who were withdrawing products containing it from sale. The other group included those whose risk management actions provided a countervailing weakening of BPA’s meaning in relation to risk i.e., toxicologists and manufacturers (Figure 3c).

– Figure 3c near here –

Around 2008-2010, the ecology of risks expanded further with the translation of reputational risk by Australian NGOs, which was heightened by the risk management actions of a range of other actors: endocrinologists who provided mounting evidence of harm; Canadian regulators whose actions demonstrated that regulatory change was possible; Canadian NGOs, since Australian NGOs could not be seen to be less effective than their activist Canadian counterparts; and Canadian retailers whose voluntary withdrawal of products containing BPA suggested that Australian NGOs might advocate successfully for similar action in their country. Australian NGOs responded by intensifying their actions to manage their reputational risk, especially following the release of the Canadian regulators’ 2008 report indicating that BPA was toxic and the 2010 ban of baby bottles containing BPA.

The ecology also expanded during this period with the translation of operational risk by

Australian regulators, which was heightened by the risk management actions of Canadian regulators and Australian NGOs. The Canadian regulators' decision to regulate BPA in baby bottles was interpreted by Australian regulators as a sign that BPA was becoming increasingly politicized, while increased Australian NGO activity generated unhelpful media attention. Such politicization threatened effective chemicals management, leading Australian regulators to intensify their risk management actions by maintaining their commitment to existing risk assessment processes, which resulted in two agencies finding that BPA did not pose a risk.

During this period, the actions of Australian NGOs to manage their translated reputational risk reinforced those of endocrinologists, Canadian regulators, Canadian NGOs and Canadian retailers in strengthening BPA's meaning in relation to risk. Accordingly, while there is still evidence of contestation, we also start to see evidence of a growing 'chain' of management actions connecting organizations and reinforcing each other in strengthening the meaning of BPA. Insofar as Australian regulators' actions to manage their operational risk reinforced the weakening effect of the risk management actions of toxicologists and manufacturers, contestation is still apparent (Figure 3d).

– Figure 3d near here –

Between 2010 and 2013, the ecology grew yet again with the translation of reputational risk by Australian retailers, heightened by actions of Australian NGOs to manage their reputational risk, and which drew consumers' attention to BPA. Consequently, Australian retailers started to withdraw products containing BPA, treating it as if it posed a risk, despite the conclusion from two sets of Australian regulators that it did not. These risk management actions further reinforced those of other organizations in strengthening the meaning of BPA in relation to risk, although some risk management actions continued to weaken this meaning (Figure 3e).

– Figure 3e near here –

By 2013, we also see evidence that previously disputed methods used by endocrinologists were slowly becoming accepted as valid. For example, in 2012, the OECD published *Guidance Document No. 150*, which was “the first comprehensive international guide on the identification of endocrine disrupting chemicals” and “provides step-by-step guidance for analysing results from standard tests and for weighing evidence for an endocrine mode of action and evidence for adverse effects in whole organisms”, including humans (OECD, 2012). In other words, modifications to the prevailing body of risk knowledge were becoming evident; and not just in the case of scientific knowledge about BPA’s effects on health and the environment. Other forms of risk knowledge – about BPA’s negative implications for organizations – were also being revised. For example, retailers had entrenched ‘BPA-free’ as a marketing category, not just for baby bottles and other polycarbonate items, but also for food cans (McTigue Pierce, 2012). Safeway affirmed that consumers had “legitimate questions about BPA” and announced that it would work with its suppliers to identify alternatives to BPA for use in food can linings (Chemical Watch, 2012); while Campbell Soup Company announced it had begun phasing out BPA from its soup can linings (Russell, 2012). Similarly, regulatory organizations increasingly acknowledged that, even though there was uncertainty about BPA’s negative effects, it was appropriate to institute bans on baby bottles containing BPA in order to protect a vulnerable population. Accordingly, bans were also put in place in the EU, USA, Brazil, China, Malaysia and South Africa by 2013 (Yingqi, 2011; Chemical Watch, 2011).

In sum, by the end of our study period, the ecology of risks had changed significantly. During the late 1990’s and early 2000’s, it was constituted by a relatively small number of translated risks. Actions taken to manage these risks interacted in such a way as to generate

opposing, contradictory effects. Strengthening risk management actions on the part of one organization, in heightening the translated risks of other organizations, elicited risk management actions on the part of others that weakened the meaning of the object in relation to risk and *vice versa*. The continuation of this pattern served to reproduce equivocality concerning BPA's meaning in relation to risk, as well as generate contestation among organizations for some considerable time. By 2013, the ecology consisted of many more translated risks and, while the various actions taken to manage them both strengthened and weakened the meaning of BPA, we can see growing evidence of a strengthening 'chain' connecting endocrinologists, Canadian regulators, Canadian NGOs, Canadian retailers, Australian NGOs, and Australian retailers. The actions taken by these organizations to manage their translated risks interacted in such a way as to generate synergistic strengthening effects i.e., strengthening risk management actions on the part of one organization heightened the translated risks of other actors and, in so doing, elicited additional strengthening risk management actions. Even when uncoordinated by the different actors, these risk management actions reinforced each other, eventually outweighing the weakening effects of the risk management actions of toxicologists, manufacturers and Australian regulators. As this strengthened meaning was stabilized through the application of the revised body of multiple forms of risk knowledge, BPA came to be constructed as a risk object.

THE CONSTRUCTION OF RISK OBJECTS IN THE CASE OF NOVEL RISKS

Our study allows us to propose a model of the process through which risk objects are constructed in the case of novel risks – one that highlights the important roles played by risk translation and the ecology of risks (Figure 4).

– Figure 4 near here –

The process begins as the discourse of risk is brought to bear on an object, but it fails to

represent a sufficiently authoritative ‘regime of truth’ to establish whether the object poses a risk or not. Subjecting an entity, activity or individual to the discourse of risk gives rise to the possibility that it might pose a risk, making it an *object of risk knowledge*. However, it does not construct it as a risk object since the object’s meaning in relation to risk cannot be determined through the application of prevailing scientific techniques. Accordingly, the meaning of the object in relation to risk becomes equivocal. It is at this point that a novel risk starts to emerge [1].³

Organizations facing this equivocality cannot use the existing body of risk knowledge to resolve it, leaving them ill-placed to know whether or not to take action on the object and, if so, what action to take. Organizations translate this equivocality into more familiar risks that they do know how to address. These *risk translations* provide organizations with a clearer basis and guide for risk management actions. As multiple risks are translated, the object of risk knowledge becomes embedded in an *ecology* of multiple risks, within which actions to manage translated risks have broader consequences: they heighten the translated risks of other organizations, leading them to intensify their risk management actions; and they strengthen or weaken the meaning of the object in relation to risk. At this early stage, these two effects interact in opposing, contradictory ways i.e., *strengthening* risk management actions on the part of some organizations, in heightening the translated risks of other organizations, elicit risk management actions on the part of other organizations that *weaken* the meaning of the object in relation to risk (and *vice versa*). The resulting countervailing effects reproduce the equivocality that already exists [2].

Over time, the ecology of risks expands as more and different types of organizations

³ Numbers here refer to numbers in Figure 4.

become aware of the possibility that the object might pose a risk. These organizations also translate its equivocal meaning into familiar risks and take risk management actions to reduce or eliminate these translated risks. Here, again, the risk management actions of one organization may heighten the translated risks of other organizations leading them to intensify their risk management actions, as well as indirectly weakening or strengthening the object's meaning in relation to risk. At this point, not only is the equivocality reproduced but there is also considerable contestation among organizations as risk management actions have contradictory effects. Contestation develops because the risk management actions of one group of organizations reinforce each other in strengthening the meaning of the object in relation to risk, while the risk management actions of another group reinforce each other in weakening it. While the risk management actions of organizations in each group may converge in their consequences for the meaning of the object of risk knowledge, individual organizations take action to manage their particular translated risk, and there may not necessarily be any explicit coordination among them [3].

The object's meaning in relation to risk begins to strengthen as the actions taken to manage translated risks interact in such a way as to generate synergistic strengthening effects. In other words, strengthening risk management actions on the part of one organization, in heightening the translated risks of other actors, elicit more strengthening risk management actions. As strengthening risk management actions target the body of knowledge, new methods, techniques and studies are developed and applied to the object in question. This increases the likelihood that risks will be 'discovered' and diminishes the relevance of earlier findings regarding the absence of risk. As they target the object of risk knowledge, more and more organizations treat it as if it does pose a risk – restricting it, withdrawing it, or eliminating it in

some way. When risk management actions reinforce each other synergistically in this way, they significantly strengthen the object's meaning in relation to risk, even without coordination among the organizations in question, and eventually outweigh the weakening effects of the risk management actions taken by other organizations. As a result, the meaning of the entity, activity or individual as a risk object becomes more widely accepted as a newly emerging consensus slowly replaces contestation [4].

For the meaning of the risk object to stabilize fully, the body of risk knowledge has to be revised. New risk knowledge derived from the development of new methods, studies, techniques and practices are incorporated into the body of risk knowledge, which in its revised form is now deemed capable of calculating the likelihood and nature of adverse effects of objects once beyond its scope. Importantly, this revised body of risk knowledge extends beyond purely scientific knowledge as diverse organizations institutionalize new practices for engaging directly with the object *as if* it posed a risk. As the revised body of risk knowledge is applied to the object, its status as a risk object becomes increasingly taken for granted [5].

Supported and held in place by the revised body of risk knowledge and the dominant discourse of risk, the entity, individual or activity is finally constructed as a risk object [6]. At this point, ironically, the risk is no longer 'novel' since the revised body of risk knowledge removes uncertainty and unfamiliarity concerning the object, the harm, and link between them. Novel risk thus refers to a *liminal* period between the discourse of risk being brought to bear on an object and its construction as a risk object.

By developing a generalizable model from our study of BPA, we show how organizations respond to equivocal meanings in relation to risk and how risk objects are constructed in the case of novel risks. Applying scientific knowledge during the liminal period does *not* necessarily

provide definitive answers as to whether a risk exists or not. In fact, rather than resolve equivocality, it is more likely to reproduce it. In the case of BPA, this liminal period lasted for a considerable time. It is, however, possible that other novel risks pass through it more quickly. For example, severe acute respiratory syndrome (SARS) was a novel risk that took both health authorities and the business community by surprise in 2002 before being contained the following year (Day et al., 2004a; Menon & Goh, 2005). Organizations in transportation, tourism, and hospitality, as well as those with supply chains and/or employees located in affected countries, appear to have translated the equivocality associated with this new illness (as well as the unprecedented health control measures taken to contain it) into operational and strategic risks relatively speedily (Day et al., 2004a; Min, 2005; Flynn & Lenaghan, 2007). As a result, the liminal period during which the SARS coronavirus posed a novel risk lasted only a short period of time – many organizations now have procedures in place to deal with it and similar diseases in what is described as the ‘new normal’ (Day et al., 2004b).

Our model also provides a basis for explaining how some objects, having been described as posing novel risks, can become *less* risky over time. For example, as a new technology, genetically modified organisms (GMOs) have been subjected to the discourse of risk, but not constructed as a risk object since: while some studies show evidence of adverse effects, others do not. Consequently, much like BPA, “science alone cannot solve the problem” of whether GMOs pose risks (Mampuy & Brom, 2015: 903). However, unlike the growing number of restrictions and bans on BPA, the number of new GMO products authorized for import or cultivation worldwide has grown considerably since 2000 (Nunes De Faria & Wieck, 2016), especially in the US where nearly 70 percent of all supermarket products had some GMO content in 2006 (Hiatt & Park, 2013).

This outcome appears to be the result of differences in the processes of risk translation. For example, US regulators – the Department of Agriculture (USDA) – translated the equivocality into a ‘legitimacy’ risk (Hiatt & Park, 2013) insofar as it was difficult for the USDA to justify its approval of manufacturers’ petitions to introduce GMO seeds on the basis of the science since it is “impossible to obtain perfect information with which to analyze all potential dangers and future environmental impacts” of GMOs (Hiatt & Park, 2013: 926). To manage this risk and shield itself from criticism, the USDA has relied on positive assessments of GMOs from the Federal Drug Administration (FDA). The FDA, meanwhile, appears to have translated the equivocal meaning of GMOs into a political risk insofar as it has been under pressure to commercialize GMOs (Jasanoff, 1995). To manage this risk, the FDA has adopted a permissive approval policy in relation to GMOs in food products (Bernauer & Meins, 2003). Accordingly, the risk management actions of both regulatory organizations weaken the meaning of GMOs in relation to risk. This weakening effect has been further reinforced by seed companies that have translated regulatory risk, which they have managed by arguing that GMOs are safe, lobbying aggressively and securing endorsements from farm associations (Bernauer & Meins, 2003; Hiatt & Park, 2013). These synergistic *weakening* effects have resulted in GMOs becoming less risky over time, despite strong concerns of NGOs over the negative effects of GMOs on human health (Bernauer & Meins, 2003), and the translation of reputational risk – and subsequent removal of GMOs from their products – by companies such as Gerber, Heinz and Frito-Lay (Anderson, 2002).

DISCUSSION AND CONCLUSION

We undertook a study of BPA between 1993 and 2013 to learn how organizations address novel risks which, unlike familiar or established risks, are not amenable to scientific techniques

associated with the prevailing body of risk knowledge. Novel risks represent a challenge for both realist and discursive approaches to risk. In the case of the former, it is difficult for an organization to act on a risk if the probability, nature and magnitude of its adverse effects cannot be ascertained. In the case of the latter, it is difficult to explain how novel risks are constructed when the techniques associated with the dominant discourse of risk lack the authority to attach a clear meaning in relation to risk to a particular entity, activity or individual. Accordingly, our first research question was: *How are risk objects constructed in the case of novel risks?* Insofar as we also wanted to explore the under-researched concept of risk translation, our second research question asked: *What is the role played by risk translation in the case of novel risks?*

In answer to the first question, our study shows that the construction of risk objects in the case of novel risks is a highly complex process. Our model indicates that novel risks start to emerge when the discourse of risk is brought to bear on an object, but the existing body of risk knowledge is unable to fix the object's meaning in relation to risk. At this point, while the entity, activity or individual is an object of risk knowledge, it has *not yet been constructed* as a risk object. Accordingly, when individuals refer to 'novel risks', they are not referring to 'risk objects', but to objects whose meaning in relation to risk is equivocal. Moreover, by the time a risk object is constructed through the revision of the body of risk knowledge, the risk is no longer novel. Novel risk thus refers to a liminal period during which some actors refer to the object as posing a risk although others do not, with the result that the object's meaning in relation to risk becomes – and remains – equivocal.

In answering our second research question, we show that, in the case of novel risks, translation involves changing equivocal meanings into different categories of organizational risk. In this way, we extend the focus in the existing literature on translating established risks, where

meanings in relation to risk are not equivocal. Risk translation in the case of novel risks enables organizations to act on novel risks – even when the techniques associated with the discourse of risk fail to provide clear answers as to whether a risk ‘exists’ or not – by taking action on other risks, with which they are more familiar. Risk translation thus transforms an ‘unknown’ object (i.e., one with equivocal meaning) into a ‘known’ object i.e., one that poses some kind of familiar, organizational risk that can be assessed and managed through tried and tested techniques, thereby rendering it actionable. (cf. Hardy & Thomas, 2017)

As a result of this process of risk translation, an *ecology* of risks emerges – constituted by the translated risks and the interactions among them. As risk translations proliferate and interact, this ecology evolves over time and, in so doing, shapes the meaning of the object that initiated the translations in the first place. Our use of the concept of ‘ecology’ is informed by disciplines such as political ecology, cultural ecology and ecological anthropology, where it refers to a complex system in which humans and non-humans are connected, and which is apprehended through “a post-positivist understanding of nature and the production of knowledge about it” (Bridge, McCarthy & Perreault, 2015: 7). Consistent with our discursive approach, it denotes a view of the material environment, not as pre-given or predetermined, but as consisting of myriad objects that can be constructed in different ways (Watts, 2015). It also emphasizes qualitative and historical research methods to draw attention to the complexity, fluidity and indeterminacy of the dynamics that arise within an ecology.

Our conceptualization of an ecology of risks allows us to show how novel risks are constructed from cumulative, ‘local’ risk translation efforts, rather than as a result of any grand strategy. Our work thus challenges the tendency in the risk literature to assume that contestation is the result of actors with fully formed identities and pre-existing interests formulating and

coordinating strategies with and against each other (e.g., Schütz & Wiedemann, 2005; Murphy, Levidow & Carr, 2006; Brunet & Houbaert, 2007; Cable, Shriver & Mix, 2008). In our study, ‘battle lines’ may appear to have been drawn in struggles among actors, but actions were not necessarily deliberately or politically aligned. For example, there was no evidence of an organized coalition among Canadian NGOs, retailers and regulators even though their actions reinforced each other. In fact, retailers and Canadian regulators would likely view their relationships with NGOs as being conflictual at times. Moreover, the same type of actor can translate equivocality into different risks or different versions of the same risk, as with regulators and scientists in our study.

We therefore question the idea that interests drive translation and argue, instead, that depending on the particular risk that is translated, organizations’ interests and behaviour may change. In other words, actions are shaped by the translated risk, rather than some predetermined conception of self-interest. For example, manufacturers acted the way that they did in our study *because* they translated regulatory risk. Had they translated reputational or strategic risk; their risk management actions would have been different. They might then have engaged in more innovation to develop new alternatives to BPA and even argued that BPA *did* pose risks in order to encourage customers to switch to the new products. The divergent actions of the regulators in our study is explained, not by radically different chemicals management contexts or by different patterns of industry lobbying in the two countries, but by the different versions of operational risk translated by the two sets of regulators.

In this way, our study supports other work that cautions against a deliberate, linear view of translation (e.g., Czarniawska & Sevón, 1996; Zilber, 2006). It supports Czarniawska’s (2009: 424) argument that translation “is recursive ... [as] actors perform actions, actions create actors

(or rather, their identities) within the context of a narrative, which is created, in turn, by actions and actors.” In other words, each act of translation changes the translator, as well as the meaning of what is translated. Accordingly, we do not assume pre-existing entities with pre-determined characteristics nor actors with essential interests. Rather, the organization’s conception of its interests is the *result* of translation processes. Organizations may act strategically *after* they have translated equivocal meanings into more familiar risks – but until then, they are more likely to be grappling with what the equivocality means for them.

Our discursive approach also draws attention to the limits of translation, which other studies do not. Specifically, our study shows that the meanings of objects of risk knowledge – even equivocal ones – are not translated into just anything; they are translated *into other categories of risks*. Our ecology of risks is thus discursive – the *meaning* of material objects changes, but in ways that are enabled and constrained by the discourse of risk. In this regard, risk translation sustains the dominant discourse of risk, even when it fails to act as a regime of truth and determine conclusively whether an entity, activity or individual poses a risk or not. By translating other categories of risk, organizations help to reproduce this discourse as categories of risk proliferate and strengthen. As Foucault (1972: 32) has pointed out, the unity or dominance of a discourse “is based not so much on the permanence and uniqueness of an object as on the space in which various objects emerge and are continuously transformed.” When risk translation transforms equivocal meanings in relation to risk into risks of completely different categories – ones with different risk objects and risk subjects – it ‘intensifies’ the discourse of risk by making its effects even more pervasive and more taken-for-granted (cf. Hardy & Thomas, 2014).

Limitations

The study is not without limitations. We were unable to systematically collect data on

BPA from all jurisdictions – to do so would have been infeasible. Therefore, the ecology of risks that we were able to map out represents a smaller part of a larger ecology involving actors from other countries that are also translating BPA’s equivocal meanings into other risks. Nonetheless, we have been able to capture important dynamics that we believe are indicative of the global ecology of risks in which BPA is situated. Also, insofar as our interviews were conducted towards the end of the period of our study, they include retrospective accounts which have well-known limitations, which we addressed by also collecting and analyzing textual data that was produced contemporaneously. A third limitation concerns our focus on the ‘successful’ construction of a risk object. We have not followed the path whereby a novel risk is *not* eventually constructed although, as discussed earlier, our model could serve as a starting point for explaining the dynamics in such a case.

Generalizability and Significance

Our model offers a promising framework for the study of other novel risks, as well as contributing more generally to research on ‘wicked problems’ and ‘grand challenges,’ which are increasingly understood in terms of novel risks to ecological, social and/or economic systems. Palmer (2012: 496) defines the former as situations where ‘the facts’ “do not identify themselves” and controversy stems “from disagreements over the types of knowledge and evidence that should count as scientific, or even as relevant, in the first place.” Ferraro, Etzion and Gehman (2015) note that the latter involve radical uncertainty. In other words, equivocality of meaning prevails. Our model provides a grounded framework for exploring how organizations can translate the equivocality associated with wicked problems and grand challenges into more familiar organizational risks so that they are better placed to address. Insofar as grand challenges implicate “multiple criteria of worth ... revealing new concerns even as they are being tackled”

(Ferraro, Etzion and Gehman, 2015: 364), our model shows that one important way in which organizations recognize ‘new concerns’ is *through* the discourse of risk i.e., by translating risks. It also shows how risk management actions taken to protect one ‘criterion of worth’ can elicit actions from other organizations trying to protect different ones. The cumulative effects of these ‘local’ actions to manage individual risks then shape a community’s or society’s ‘global’ response to the grand challenge – through the ecology of risks.

To take the example of climate change, commentators often despair that ‘the science’ has failed to convince organizations to take more definitive action on carbon emissions. Those who fail to take action are often classified as climate change deniers and sceptics. Our model suggests a rather more complex situation – one in which ‘the science’ does not necessarily provide all the answers. For example, scientific studies may have established that the earth is warming, but atmospheric scientists have not reached a consensus as to the timeline of increasing average temperatures (Knutti & Sedláček, 2013), even though this timeline is key to understanding when and how risks will materialize. Even if the timeline could be agreed, disagreements would still remain among hydrologists regarding risks of flooding, epidemiologists regarding risks of malaria, and ecologists regarding risks of biodiversity losses (IPCC, 2014), economists regarding risks to the economy, and so forth. In other words, ‘the science’ is not as unequivocal as one might think, particularly when we consider the wide range of activities implicated in anthropogenic climate change, which vary from producing coal to driving cars to building with concrete to eating meat – to name but a few. Understanding exactly what the adverse consequences of specific activities are, whom they affect, and whether and how they are connected to increasing temperatures is not straightforward.

When organizations face such equivocality, science cannot necessarily lay it to rest. In

fact, introducing additional science during this liminal period may simply increase equivocality and contestation, as our study shows. It is also important to note that this liminal period can last a very long time: BPA's lasted 20 years. Risks associated with climate change are even more complex, affecting a larger and more diverse series of sectors, each with its own set of public, private and civil society organizations. It is not surprising, therefore, if a high degree of equivocality endures for a considerable time in relation to the risks of climate change.

A second insight, following from this, is that 'the science', in and of itself, is not the only force shaping society's response to climate change. The risks translated by other organizations and the ecology of risks constituted by them are equally important, although not necessarily in a predictable and deterministic way since a wide range of different risks are translated and, while some risk management actions may strengthen meanings in relation to risk, others will weaken them. Moreover, some actions that might be expected to strengthen the meaning of particular activities in relation to risk can inadvertently have the opposite effect. For example, governments that translate equivocality into a version of political risk in which inaction on climate change threatens their re-election chances are likely to manage that risk by restricting carbon-intensive activities in some way. However, if this heightens the regulatory risk translated by coal producers and other companies dependent on fossil fuel, these organizations will respond by intensifying their own risk management actions in the form of denying climate change and lobbying against controls on greenhouse gases.

A third insight is that, instead of seeing an inherently adversarial situation between those who are 'for' and 'against' action to mitigate climate change, it may be more productive for proponents of action on climate change to attend to – and influence – the risks that different organizations translate. For example, the more that retailers translate equivocality into

reputational risk and take action to lower the carbon footprint of their supply chains, the more their suppliers are likely to translate a strategic risk (i.e., one that threatens their business) that might best be managed by investing in less carbon-intensive technologies. This, in turn, heightens their own suppliers' strategic risk, and so forth – all the way back up the supply chain to energy producers. In this way, the current focus of these companies on regulatory risk, which has led them to oppose carbon legislation and taxes, can be switched to a focus on strategic risk, the management of which is much more likely to involve the reduction of carbon-intensive activities. Similarly, retailers are more likely to translate equivocality into reputational risk in circumstances where NGOs also translate reputational risk and manage it by educating consumers whose greater awareness increases retailers' reputational risk. This might create conflict between retailers and NGOs but, nonetheless, their risk management actions will reinforce each other in strengthening the meanings of carbon-intensive activities in relation to risk. Our model shows that such synergistic, strengthening connections can be created without formal coalitions and cooperation if sufficient attention is paid to the configuration of translated risks in the ecology.

Finally, our model indicates that if activities implicated in anthropogenic climate change are to be constructed as risk objects, the body of risk knowledge requires revision in order that it becomes deemed capable of accurately calculating the adverse effects with which activities are associated. This means not only incorporating new scientific practices into the body of risk knowledge, but also new knowledge about *organizational* risks such as: information on how customer dissatisfaction can negatively impact retailers' sales figures in the event that reputational risks materialize; forward-looking assessments of the susceptibility of organizations to being left behind in terms of renewable energy technologies in the event that strategic risks

materialize: and more enlightened thinking about the costs of supply chain disruptions in the event that extreme weather events cause operational risks to materialize. In this way, the status of carbon-intensive activities as risk objects will become increasingly accepted, leading more organization to abandon them.

In conclusion, our research contributes to theory building or ‘nascent’ theory (Edmondson & McManus, 2007) through an inductive, qualitative study of an ‘extreme’ case (see Bansal, Smith & Vaara, 2018). In this way, we have been able to develop a model of the process whereby risk objects are constructed in the case of novel risks and highlight the important role played by translated risks and the ecology to which they give rise. Accordingly, we suggest that organizational scholars can learn more about – and make contributions to resolving – some of the most pressing issues of our generation by drawing on and enriching the concepts of risk translation and ecology of risks.

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Table 1: Interviews Conducted

Government regulators	8 in Canada (C1 – C8) 11 in Australia (A1 – A11)
Scientists	6 in Canada (C9 – C14) 8 in Australia (A12 – A19)
Manufacturers	7 in Canada (C15 – C21) 5 in Australia (A20 – A24)
Retailers	1 in Canada (C22) 2 in Australia (A25 – A26)
NGO representatives	6 in Canada (C23 – C28) 4 in Australia (A27 – A30)

Table 2: Summary of Translated Risks

Actors Accounts of Negative Impacts associated with BPA	The Risk Subject	The Risk Object	The Translated Risk
Endocrinologists link BPA to methodological bias by other scientists (toxicologists) who work with the ‘dose makes the poison’ paradigm, which leads to erroneous research findings	Endocrinologists	Other scientists (toxicologists)	<i>Professional risk</i> : threat to the integrity of their profession
Toxicologists link BPA to methodological bias by other scientists (endocrinologists) who work with unvalidated methods, which leads to erroneous research findings	Toxicologists	Other scientists (endocrinologists)	<i>Professional risk</i> : threat to the integrity of their profession
Chemical manufacturers link BPA to possible new regulations by governments, which will impose additional costs and restrict business opportunities	Manufacturers	Government	<i>Regulatory risk</i> : threat to their business from government regulation
Canadian and Australian retailers link BPA to specific products which, if they continue to sell them, will cause a consumer backlash	Canadian and Australian retailers	Products containing BPA	<i>Reputational risk</i> : threat to their organizational reputation
Canadian and Australian NGOs link BPA to specific products which, if they fail to act on them, will damage the NGO’s image	Canadian and Australian NGOs	Products containing BPA	<i>Reputational risk</i> : threat to their organizational reputation
Canadian regulators link BPA to particular challenges posed by legacy and endocrine-disrupting chemicals which, if not addressed, will result in ineffective chemicals management	Canadian regulators	Existing chemicals management processes	<i>Operational risk</i> : threat to effective operation of chemicals management
Australian regulators link BPA to emotional debate, public fear and political pressures which, if acceded to, will result in ineffective chemicals management	Australian regulators	Deviation from existing chemicals management processes	<i>Operational risk</i> : threat to effective operation of chemicals management

Table 3: Effect of Actions to Manage Translated Risks on Other Actors' Translated Risks

<i>Risk subject and their translated risk</i>	Illustrative evidence that the risk subject's actions to manage their translated risk heightened other actors' translated risks
<i>Endocrinologists' professional risk</i>	<i>Toxicologists' professional risk:</i> Toxicologists view attacks by endocrinologists on their funding sources as a 'McCarthy-like' threat to scientific integrity: "My views on this area have been the same before I was funded by industry, while I was funded by industry and since I've been funded by industry. And if Fred vom Saal and his ilk think I lie for industry, I can tell him he's crazy. ... And I think it's a McCarthy-like tactic. And it's an outright lie" (Safe, 1998).
	<i>Manufacturers' regulatory risk:</i> Manufacturers view endocrinologists' claims about negative health effects of their products as an invitation for governments to regulate and hence a threat to their profitability: "taking precautions that potentially could take a vast array of plastics, pesticides, other very important tools that mankind uses out of the marketplace because we don't know the answers to new questions that may be invented daily, would be really short-sighted. ... you have to look on the other side of the equation, which is all about the benefits that products provide to man's existence, and whether those benefits are substantial as well (Vroom, 1998).
	<i>Canadian NGOs' reputational risk:</i> Canadian NGOs view inaction on BPA, in the face of the growing acceptance of endocrinologists' findings, as a threat to their reputations: "Certainly, the scientific consensus with some of these chemicals has solidified relatively recently. ... I think this is - to overuse a phrase, I mean, this issue's very clearly at a tipping point in the public consciousness" (Canadian NGO representative [C24]).
	<i>Canadian regulators' operational risk:</i> Canadian regulators cite studies of endocrinologists when raising questions about the effectiveness of existing chemicals management processes prior to the CMP: "The endocrine system, I would say, is an important system that we consider in our assessments. There is a lot of discussion going on too about will it change the fundamental premises of toxicology and dose response and all that. ... Our stakeholders all are very much preoccupied about what we're doing on endocrine disruption. ... They think we need to have a much more clear public messaging about what we're doing and why and what we will be doing and what we're involved in. We're going to be moving that way" (Canadian regulator [C8]).
	<i>Australian NGOs' reputational risk:</i> Australian NGOs view inaction on BPA, in the face of the growing acceptance of endocrinologists' findings, as a threat to their reputations: "It is essential that the latest and widespread scientific consensus be taken into account so that eventually BPA, as well as all endocrine disrupting chemicals (EDCs) are phased out from all consumer products as soon as possible" (Friends of the Earth Australia & Europe, 2008b: 3).
<i>Toxicologists' professional risk</i>	<i>Endocrinologists' professional risk:</i> Endocrinologists view the dissemination of toxicologists' perspective as a threat to science and to public health: "Policymakers in Europe and elsewhere should base their decisions upon science ... The letter by Dietrich et al. does the European Commission, science – including the field of toxicology– and, most importantly, public health a profound disservice" (Gore et al., 2013: 2)
<i>Manufacturers' regulatory risk</i>	<i>Endocrinologists' professional risk:</i> Endocrinologists view industry's attack on their research methods as a threat to scientific integrity: "The role they [industry] are playing now more is to obfuscate the issue, to attack the science that has been coming from scientists that have been getting NSF grants and NIH grants for years. They are trying to discredit science" (Colborn, 1998).
<i>Canadian NGOs' reputational risk</i>	<i>Canadian regulators' operational risk:</i> Canadian regulators interpret NGOs' suggestion that the operation of Canada's chemicals management regime is compromised as a threat: "I find it's more we're often in a defensive mode, giving information because they're interested or they don't think we're doing enough in a certain area or focusing on the wrong area" (Canadian regulator [C8]).
	<i>Canadian retailers' reputational risk:</i> Canadian retailers view the success of Canadian NGOs at awakening the public to BPA's health hazards as a threat to their reputation: "These were products that, as I said before, we sold, literally tens of thousands of them every year and then overnight, [customers] were bringing them back to us, you know, 18,000 in the end, out of concern for the risks that BPA might pose to their health" (Canadian retailer [C22]).
	<i>Australian NGOs' reputational risk:</i> Australian NGOs reference the successful contribution of Canadian NGOs to getting a ban on BPA in Canada as putting pressure on them: "Probably the only reason we got anywhere with it, we were lucky enough to have the boys out from

	<p>Canada” (Australian NGO representative [A27]).</p> <p><i>Manufacturers’ regulatory risk:</i> Manufacturers view the success of Canadian NGOs at awakening the public to BPA’s health hazards as increasing the threat of regulation: “So there was this swirl – self-feeding swirl – where ... the NGOs would get interested. The media would get interested. It tended to swirl around quite a bit. But it really – but it wouldn’t – I don’t think it would be so interesting without the broader subject of endocrine disruption out there. It’s the more overarching subject that regulators are trying to deal with” (manufacturer [C20]).</p>
<i>Canadian regulators’ operational risk</i>	<p><i>Canadian NGOs’ reputational risk:</i> Canadian NGOs view the implementation of Canada’s CMP as potentially exposing them to criticism of their competence, leading them to engage in capacity-building: “The objective of the CBP [capacity-building project] is to strengthen the capacity of the civil society/non-government organization (NGO) sector in the areas of information gathering and knowledge translation in order to meet the Government of Canada’s requirements for timely, evidence-based input to the CMP” (Canadian Environmental Network, 2010: 5).</p> <p><i>Canadian retailers’ reputational risk:</i> Retailers engage in voluntary withdrawals of polycarbonate products containing BPA following reports of the pending release of Canadian regulators’ draft screening assessment for BPA: “Two of Canada’s major retailers said Tuesday they are pulling plastic water and baby bottles that contain the controversial chemical bisphenol A, in anticipation of a Health Canada labelling it a dangerous substance” (<i>Globe and Mail</i>, 2008 04 15).</p> <p><i>Manufacturers’ regulatory risk:</i> Manufacturers view Canada’s novel approach to BPA under the CMP as increasing the threat of regulations: “Bisphenol A is one of the largest volume chemicals made in the world, and any decision by Ottawa to restrict it would have major economic impacts if other countries follow. Last month, four major bisphenol A manufacturers, Dow Chemical Co., GE Plastics, Bayer MaterialScience, and Sunoco Chemicals, hired Tactix Government Consulting, a well-placed Ottawa-based lobbying firm, to help them respond to the review. The industry disputes assertions that bisphenol A is dangerous” (<i>Globe and Mail</i>, 2007 06 20).</p> <p><i>Australian NGOs’ reputational risk:</i> Australian NGOs state that the ban of BPA in Canada drew attention to BPA among the Australian public who then pushed for action by the NGOs: “I mean it’s very frustrating for the community when they see other regulators in other parts of the world taking very decisive action on certain things and our own regulator is not. ... It leads to lots of anger in the community there are a lot of really angry people from all sectors” (Australian NGO representative [A29]).</p> <p><i>Australian regulators’ operational risk:</i> Australian regulators view Canadian regulators’ decision to ban baby bottles containing BPA as ‘political’, putting pressure on them to deviate from existing risk assessment practices and thereby threatening effective chemicals management: “But you’ve got this chemical coming out which is such tiny levels and in fact the hazard isn’t all that great. In fact the hazard is a bit iffy even in our view. ... But then what happens is it gets in the media and then we get asked well EU just banned it, Canada banned it, why can’t you ban it?” (Australian regulator [A8]).</p>
<i>Australian NGOs’ reputational risk</i>	<p><i>Australian regulators’ operational risk:</i> Australian regulators complain of NGOs’ exaggeration and emotional hyping of the BPA issue as putting pressure on them to deviate from existing risk assessment practices and thereby threatening effective chemicals management: “some of the other stakeholders [including NGOs] aren’t constrained by facts or by scientific rigour, and the media is engaging in infotainment” (Australian regulator [A9]).</p> <p><i>Australian retailers’ reputational risk:</i> Australian retailers acknowledge the success of NGOs’ efforts to keep BPA in the media and to shape consumer sentiment, which threatens their reputation if they do not take action on baby bottles: “So the other thing that I guess probably has happened a fair bit in the last little while ... is that there has been a significant advent in things like viral email campaigns [led by NGOs]. They do drive opinion in the customer base” (Australian retailer [A26]).</p>

FIGURE 1: Data Structure

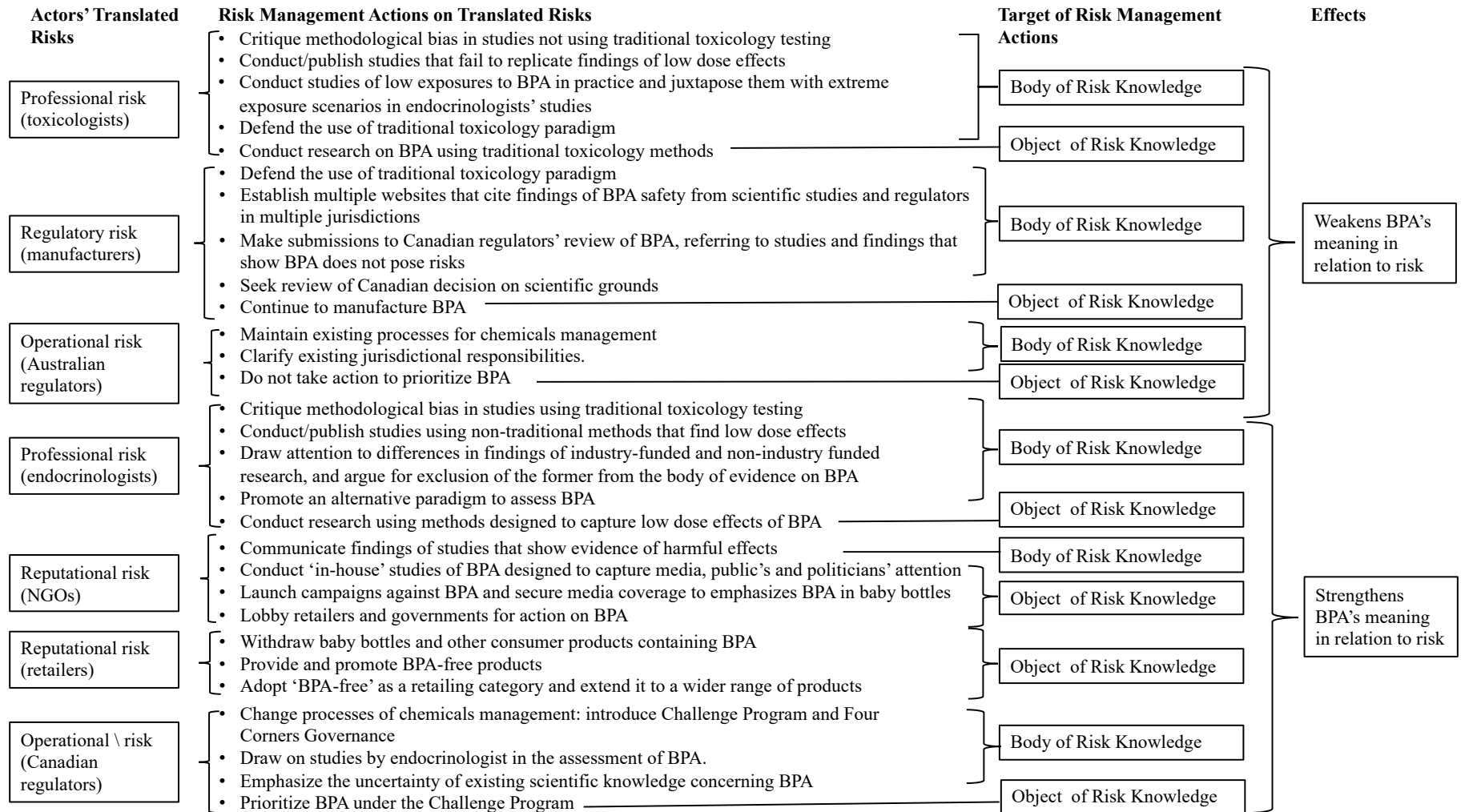


FIGURE 2: Timeline of Risk Management Actions

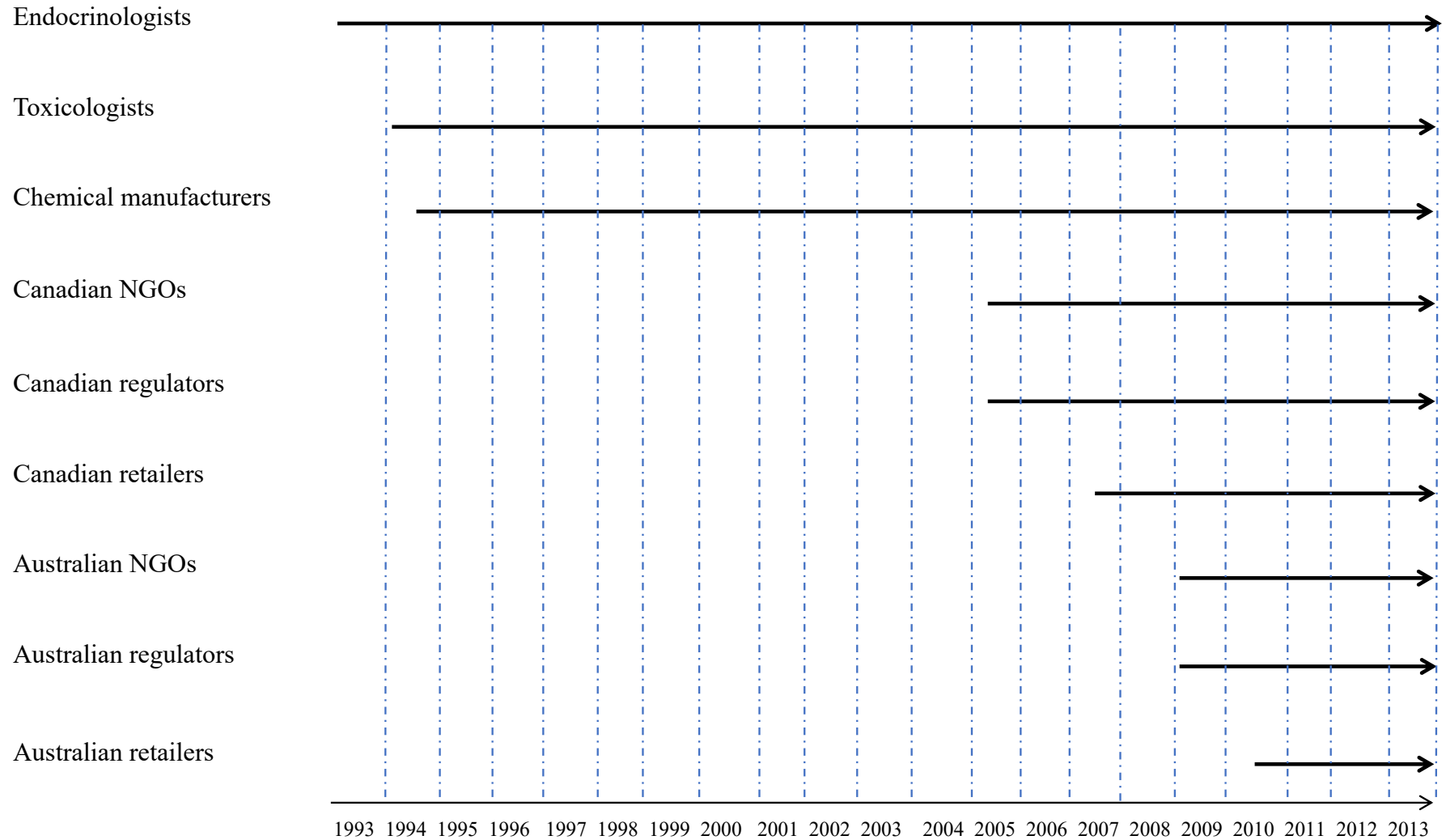


FIGURE 3: Ecology of Risks 1993-2013

FIGURE 3a:
c. 1993-mid
2000s

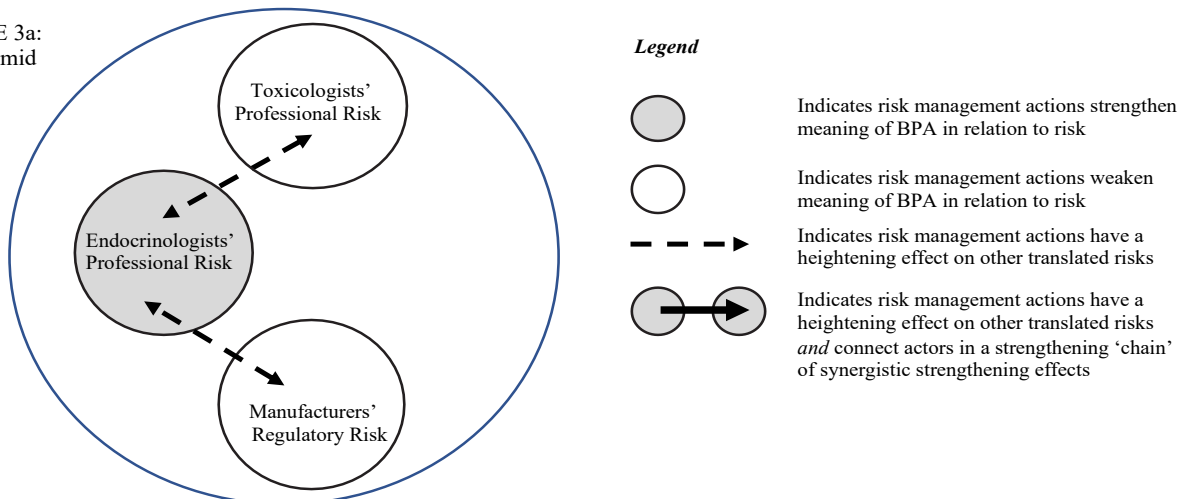


FIGURE 3b:
c. 2005-2007

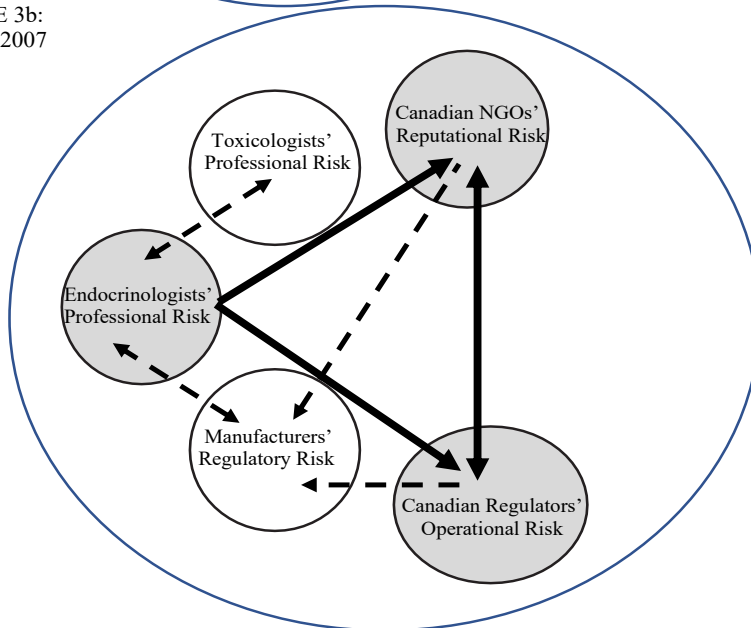


FIGURE 3c:
c. 2007-2008

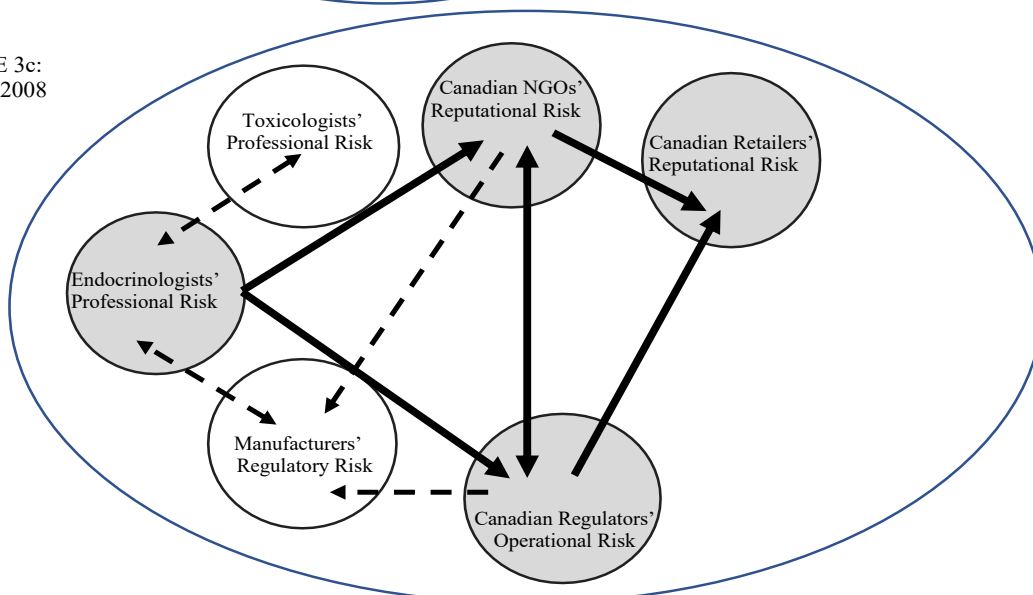


FIGURE 3 CONTINUED: Ecology of Risks 1993-2013

FIGURE 3d:
c. 2008-2010

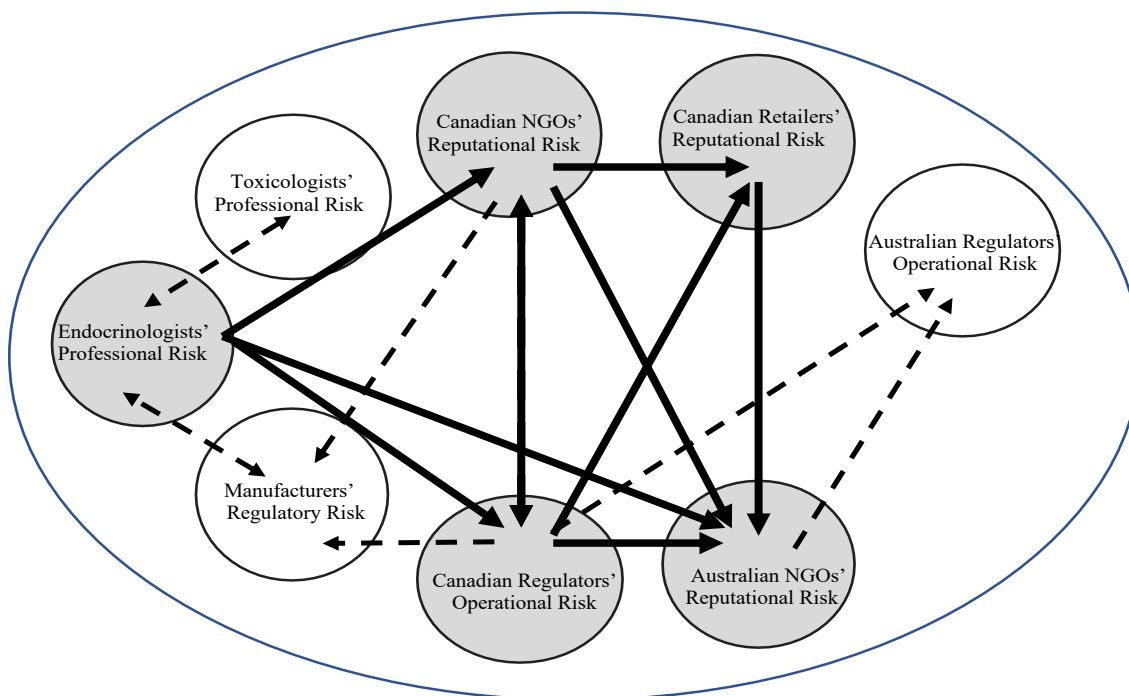


FIGURE 3e:
c. 2010-2013

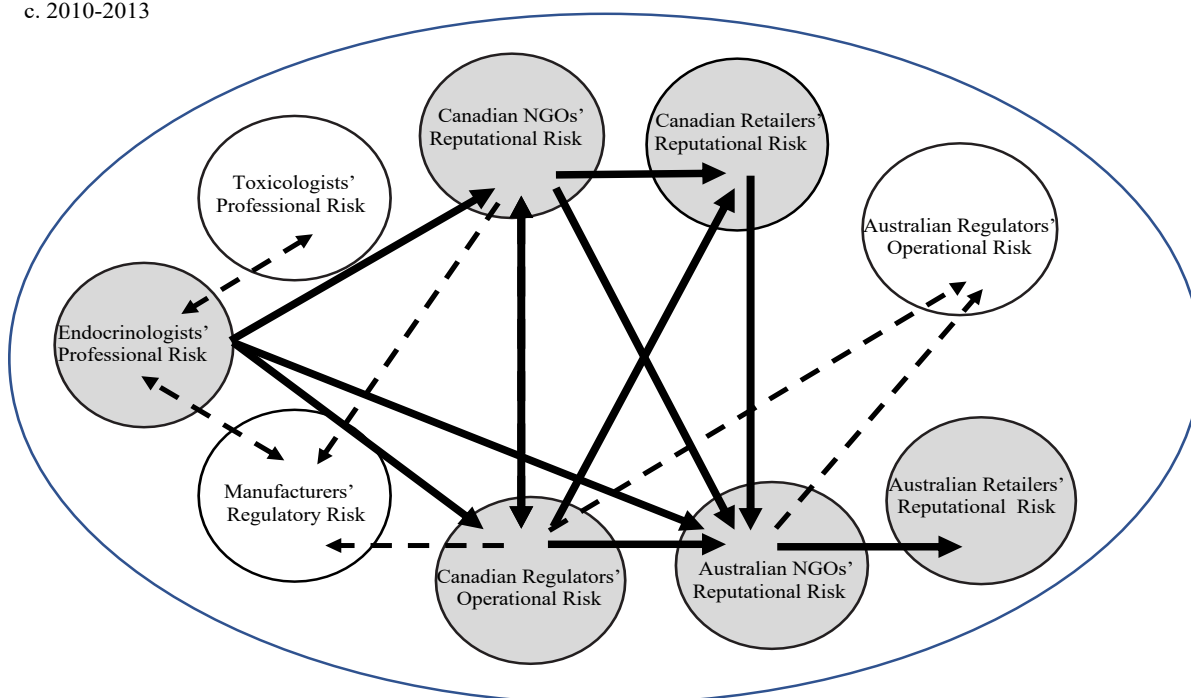
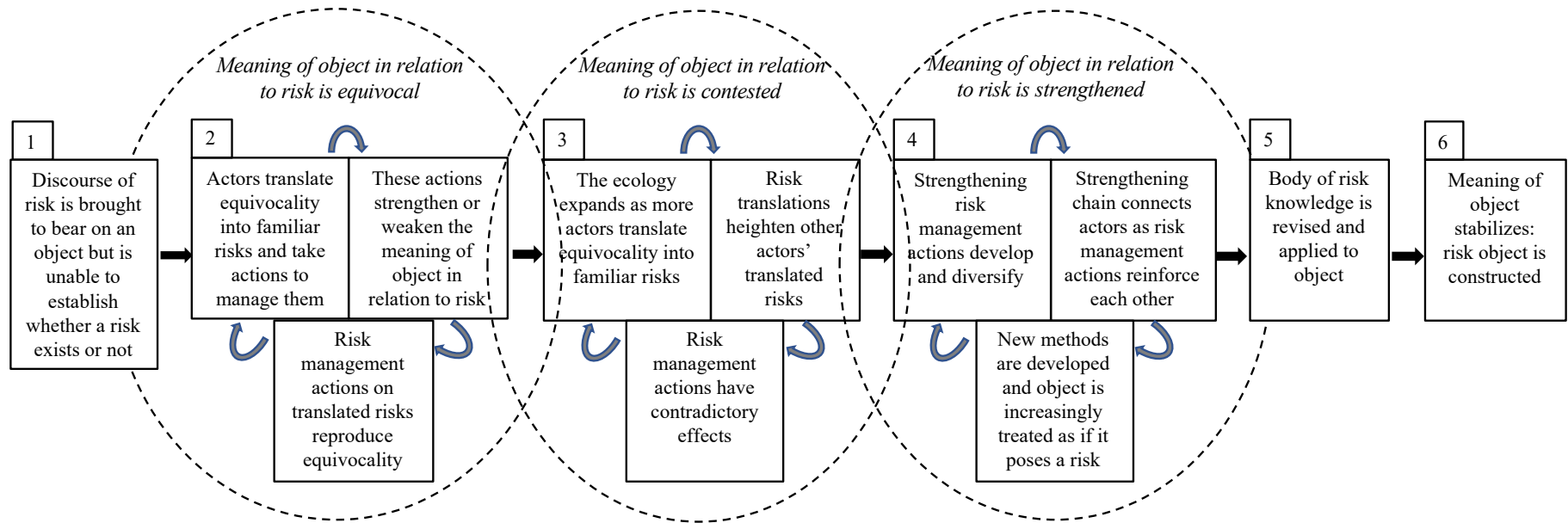


FIGURE 4: Process of Constructing a Risk Object



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